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**A coral reef fishery for aquarium fish- the Fiji experience**

by

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**Introduction**

1. Although situated more than 4000 km to the east of the central Indo-Malayan Archipelago, the coral reefs of Fiji support a rich fish fauna (> 700 species- Springer, pers. comm.) including many brilliantly coloured species of interest to the aquarium fish industry. Equally importantly, Fiji lies at the crossroads of the Central South Pacific and is well served by airline connections to many countries. Not surprisingly, it has attracted the attention of aquarium fish traders. Under the Fisheries Regulations (Cap. 135) however, the export of live fish "of any kind whatsoever" is prohibited, with provision for exemption by the Director of Agriculture.

2. A local company, Fiji Biomerine Pty Ltd, was initially granted sole rights to export aquarium fish in the 1970's. Collection commenced in 1976, in conjunction with the operation of a display aquarium in Central Suva. Production declined from a peak of 30,500 fish in 1976 till operations ceased in 1982 (Lewis, 1985).

3. In 1984, a second company was given approval to operate out of the Pacific Harbour area near Suva, after numerous proposals were reviewed. This paper examines the operation of this fishery and its implications for similar developments elsewhere in the region.

**The marine aquarium fish trade**

4. The international trade in aquarium fish, marine and fresh water, is enormous. In 1979, the retail value of tropical aquarium fish was estimated at \$ 1.8 billion (Anon, 1979) and is likely to have increased considerably since then. Marine fish, which unlike their freshwater counterparts, are not currently bred in captivity, account for 20% of the value of this trade (10 % of volume), all based on the capture of wild stock. Major markets are the industrialised countries of USA, Western Europe and Japan, with the Philippines, Indonesia, Hawaii and Sri Lanka major suppliers.

4. Trade requirements are primarily for juveniles of coral reef species, which are often more colourful than adults, are easier to handle, and require less space in aquaria and in transport. The most important families are the butterflyfishes (Chaetodontidae), angelfishes (Pomacanthidae), surgeonfishes (Acanthuridae), wrasses (Labridae), moorish idols (Zanclidae), basslets (Subfamily Anthiinae of family Serranidae), squirrelfishes (Holocentridae), damselfishes (Pomacentridae), triggerfishes (Balistidae), filefish (Monacanthidae), scorpionfishes (Scorpaenidae, especially Pterois), hawkfishes (Cirrhitidae), trunkfishes (Ostraciidae) and puffers (Tetraodontidae, especially Canthigaster) (Randall, 1987). Individual retail values may reach several hundred dollars in exceptional cases, but are usually less than \$10.

5. Fish are transported almost entirely by air freight in airtight oxygen and water-filled plastic bags, since travel time generally needs to be under 40 hrs to ensure good survival. Air freight costs may account for 40% of the C. and F. value (Anon, 1987). FOB export value may be less than 10% of the final retail value in some cases, and 25% of wholesale value.

### Rationale of the fishery

6. The collection of colourful, attractive reef fish species for commercial sale invariably attracts comments for and against. As a renewable reef resource, aquarium fish are the basis of sizable fisheries in countries where most conventional reef resources are heavily exploited, or economic alternatives are limited. Albaladejo and Corpuz (1981) note that aquarium fish were within the top ten fisheries exports in value for the Philippines and De Silva (in Sale 1985) reported that 50,000 people are employed in the Sri Lanka fishery. On the other hand, depletion through commercial collection at aesthetic and ecological cost is a valid concern, particularly where tourism is concerned or where juveniles of food species harvested as adults are collected in large numbers.

7. Recruitment dynamics of the species exploited and the method of collection are the key issues. (In general, very few of the species collected are juveniles of commercially important food fishes). Recruitment dynamics of planktonic reef fish larvae are exceedingly complex (Richards and Lindeman, 1987) and are not well understood for most species. Doherty (1987) notes the extreme view points that on the one hand larval supply limits population density of adults, as opposed to the view that highly fecund fishes "saturate" the environment with juveniles whose survival tracks available resource levels.

8. This debate aside, natural mortality of reef fish juveniles between settlement and adulthood is undoubtedly very high, and it is argued, in the absence of hard data, that mortality due to collection activities (fishing mortality) never approaches this. The empirical observations of collectors lend to support this view.

9. Much of the opposition to the commercial collection of marine aquarium fishes has been fuelled by the methods employed by unscrupulous collectors. Randall (1987) gives a detailed account of the widespread and harmful use of sodium cyanide as a narcotic in the Philippines and Indonesia, as well as the less common use of chemicals such as rotenone, quinaldine and insecticides, and dynamite. Retarded death i.e. poor subsequent survival in aquaria and possible environmental damage are the consequences of chemical collection and the use of chemicals and explosives to catch fish is banned in most countries. Breaking up coral heads to capture cryptic species and those seeking refuge (eg. Paracanthurus) also occurs. Quality aquarium fish are captured using fine-mesh nylon nets only.

10. It is also argued, somewhat negatively, that in cyclone-prone tropical areas, episodic hurricane and storm effects do more damage to site-attached aquarium fish populations through habitat destruction than do collection activities. Pfeffer and Tribble (1985) for example, describe the collapse of an aquarium fish fishery in Oahu, Hawaii following hurricane damage, and predicted that complete recovery would take several decades.

## **The Fiji operation**

### History

11. Recognising the valid concerns about the unregulated collection of marine aquarium fish and in view of the increasing number of enquiries being received from potential collectors, mostly overseas, the Fisheries Division adopted in 1982, a series of guidelines for evaluating non-local proposals to set up collection operations. These were later incorporated into guidelines approved by Cabinet (Table 1).

12. Of the many enquiries received, only one from a company active in Hawaii and with good credentials within the industry, was considered to meet these criteria. The proposal was approved and the company, Aquarium Fish (Fiji) Ltd. began operations in August 1984.

### Fishing methods

13. All fish are collected with either fine mesh, hand scoop or barrier nets, at depths of 2-60 m. Those collected at depth are either "staged" to the surface or the swim bladder pierced with a fine needle to circumvent the need for decompression. Fish are then transferred from the collection area in aerated bins to onshore storage, where their health is carefully monitored. The fish are not fed prior to packing, to reduce excretory waste build-up during air shipment.

### Transport and survival

14. Transport is effected in double-walled plastics bags pumped with oxygen prior to sealing, and carefully packed in standard size boxes, these being the freight unit. An export licence is required for each shipment, at which time details of catch by species and area are supplied.

15. Less than 0.5 % mortality has been experienced from arrival in the onshore holding tanks to delivery at the wholesale outlet overseas. This compares with the 23.5% mortality estimated for Sri Lankan fish (Anon, 1986, based on Wood, 1985).

16. Markets, whilst still primarily the USA (72%) and the United Kingdom (19%) now also include the Netherlands, Germany and Italy (Anon, 1987).

### Species composition

17. Table 2 lists the catch composition by family and major species, for the years 1984-1986. Over 110 species have regularly been exported since operations commenced, including numerous species not previously recorded from Fiji and at least one undescribed species (Randall, pers. comm.)

18. A single species, the Fiji devil, an attractive local colour variant of the widely distributed Abudefduf cyaneus, makes up approximately 25% of the catch by number. It provides important bulk to supplement the smaller numbers of higher value deep-water species. FOB values of various species range between US\$ 0.25 to US\$ 8.00 per individual.

19. Only a single endemic species, Siganus usui, is regularly collected. Marked seasonal and year-year variation is noted in the abundance of many species (eg. Coris) and these data could well provide some useful insights into recruitment dynamics of reef fishes.

### Catch by area

20. Collection was initially restricted to various habitats around Beqa Island and its barrier reef, these providing a good "mix" of species for export. With the greater involvement of local collectors, this collection area has gradually expanded to various localities along 50 km of coastline between Serua and Suva. Data on catch by area is available but has yet to be analysed in detail.

21. Other areas, eg Bau waters, have been surveyed and found to hold viable quantities of desirable species of fish, but have not been exploited as yet. The current harvest area represents a very small proportion of the total area of Fiji's reefs.

### Total catch

22. Total exports (there are no local sales, mainly because the equipment required to set up marine aquaria is not generally available and the potential market is small) increased through 1985-1987 from 59,404 to 83,109 fish but have now stabilised, primarily due to the company's inability to handle and pack more fish without employing additional skilled staff. The fishery has thus operated within self-imposed limits.

23. The proportion of the catch taken by local divers has increased from less than 10% in 1984 to over 90% in 1987, in accordance with the Exploitation Guidelines.

### Management of the fishery

24. Other than self-imposed observance of the Exploitation Guidelines, no management measures have been necessary. No other overseas operators have met the criteria laid down. One local operator collected fish for a brief period, but bad handling and resultant high in-transit mortality lead to the rapid demise of the operation, unfortunately at some temporary cost to the otherwise very good name of Fiji exports. It is also likely that chemicals were used to collect these fish.

25. No conservation guidelines have been imposed, nor has a ceiling been set on annual export numbers, primarily because no diminution in catch rates has been detected. No complaints have been received from artisanal fishermen operating in the same area, and the collection area has continued to expand whilst the catch has remained relatively stable.

26. The customary fishing rights provide another potential check on operations. All fish are taken within areas subject to traditional usage rights and as such, obtaining a permit annually from the traditional owners is a necessary prerequisite to the issue of a licence by the Fisheries Division (In theory, this licence should also be endorsed with an exemption covering the use of small mesh barrier nets). Without a good understanding of the nature of the operation by traditional owners, this requirement can be counter productive. Meaningful involvement of ownership unit members in the collection process, as encouraged under the Guidelines, has been beneficial in this regard.

### Conclusions

27. In terms of the Exploitation Guidelines, intended to ensure rational resource exploitation to the benefit of resource custodians and the local economy, the operation must be judged a success. Local collectors now account for over 90% of fish numbers, only approved methods are used and fish survival at all stages has been very high. High quality information on the catch have been provided, resource custodians are receiving a fair resource rental and are involved in collection, and no user conflicts have developed. The FOB value of exports now exceeds US\$ 100,000 per year, despite problems in 1987 with airfreight disruptions. The company is clearly keen to protect the reputation for quality that Fiji fish, as a generic item, have built up, and high standards are maintained at all stages of the operation.

28. In ecological terms, the impact of the fishery is more difficult to quantify. The total catch (approximately 80,000 fish p.a) has stabilised whilst the area of collection has considerably increased, and is modest relative to other countries. Randall (1987) reports that there were 66 permits for commercial collection issued in Hawaii in 1982, and 150,500 fish (worth US\$ 277,300) were collected in 1981-1982. The main islands of Hawaii have a much smaller area of reef habitat than Fiji, and the industry there has coexisted harmoniously in a multiple-use situation for many years. Of the approximately 110 species regularly collected in Fiji, less than ten are of even minor commercial importance as food fish (eg. Coris, Gaterin, Zebrosoma, Pomacanthus), so there is negligible user conflict in this regard.

29. As noted earlier, recruitment dynamics are not well understood, but may be patchy on micro and meso-scales (Doherty, 1987). The mode of collection (nets only) also means that areas with ample cover are generally not suitable for collection, the fish easily escaping into this cover. Recruitment into fished areas, a fairly small percentage of total reef habitat, can thus occur easily from contiguous unfished areas. As a result, the issue of depletion of rare species has not been addressed, nor has the concept of refuge areas adjacent to collecting areas.

30. In summary, the Fiji experience with a recently developed regulated coral reef fishery for marine aquarium fish has been a model one, with measurable socio-economic benefits resulting from the controlled exploitation of a renewable reef resource. No deleterious ecological effects have been noted.

## References

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**Table 1:**

**Exploitation Guidelines for Marine Aquarium Fish, as approved by Cabinet August 1984.**

- 1- Operators exporting live fish should be licenced and limited to a single operator, at least till July 1985, giving the sole operator a 12-month period of grace.
- 2- Future operators should be of high international repute with a proven record in the trade (this is easily checked).
- 3- Involvement of resource custodians in the collection process should be to the maximum extent practicable. There should be a training component in this process.
- 4- The use of chemicals or poisons for collection to be prohibited.
- 5- Exports permits required for each shipment, with quantities and species to be noted.
- 6- Conservation guidelines to be formulated by the Fisheries Division in consultation with the operator. A ceiling on the total number of fish exported per year to be set, taking into account the area to be fished.
- 7- Efforts should be made to ensure that collection activities do not conflict with other uses eg. tourist diving.
- 8- With a single moderate-level operator it is not necessary at this stage to consider reserves, closed-seasons and other conservation measures. The Fisheries Division should however closely monitor the development of this trade.

**Table 2:**

Composition of the aquarium fish catch, by family and major species, for the years 1984-1986. (percentage by number only are given both as family totals and for the major species; many of the 110 or 50 species exported are in small numbers).

Family	1986	1987
<b>POMACANTHIDAE (Angels)</b>	23.69	16.58
Centropyge bicolor	8.58	5.80
C. flavissimus	5.90	4.43
<b>CHAETODONTIDAE (Butterflies)</b>	14.82	9.37
Chaetodon pelewensis	2.81	1.53
<b>SERRANIDAE</b>		
Sub-Family <b>ANTHIINAE (Basslets)</b>	6.38	4.65
Anthias squamipinnis	5.76	4.47
<b>POMACENTRIDAE (Damsels)</b>	41.48	37.17
Abedufduf cyaneus	25.34	24.43
A. chrysopterus	2.90	2.02
<b>SCORPAENIDAE (Lionfish)</b>	0.32	0.15
Dendrochirus zebra	0.16	0.06
<b>ACANTHURIDAE (Tangs)</b>	1.15	1.36
Paracanthurus hepatus	0.74	1.12
<b>BALISTIDAE (Triggers)</b>	1.13	1.36
Odonus niger	0.83	0.57
<b>CIRRHITIDAE (Hawks)</b>	0.69	2.62
<b>MONACANTHIDAE (Files)</b>	0.16	1.07
<b>Gobiidae (Gobies)</b>	0.68	0.01
<b>LABRIDAE (Wrasses)</b>	3.07	11.14
Coris gaimardi	0.35	4.24
<b>BLENNIDAE (Blennies)</b>	4.95	4.13
Meicanthus atrodorsalis ovalauensi		
<b>Others (ZANCLIDAE, TETRAODONTIDAE, GASTERINIDAE, MULLIDAE, SIGANIDAE)</b>	1.43	7.60
Total number of fish exported	71,840	83,109