

- HINGCO, T. G. & R. RIVERA. (1991). Aquarium fish industry in the Philippines: toward development or destruction? In: L.M. Chou et al. (eds). Towards an integrated management of tropical coastal resources. ICLARM Conference Proceedings, 22, 455p. 249–253.
- MIYASAKA, A. (1991). Hawaii's aquarium fish industry, a business profile. Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii, 15p.
- MIYASAKA, A. (1994). Status report aquarium fish collections, fiscal year 1993–1993. Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii, 8p.
- RANDALL, J. E. (1987). Collecting reef fishes for aquaria. In: B. Salvat (ed.) Human impacts on coral reefs: facts and recommendations. Antenne Museum-EPHE, French Polynesia, 253p. 30–39.
- SADOVY, Y. (1992). A preliminary assessment of the marine aquarium export trade in Puerto Rico. Proc. 7th Int. Coral Reef Symp., Guam, 2: 1014–1022.
- SIESWERDA, P. & J. MARQUARDT. (1995). Saving fragile coral ecosystems requires cooperation. Wildlife Cons., July – August 1995: 18–25.
- VINCENT, A.C.J. (1996). The international trade in sea-horses. TRAFFIC International.
- WOOD, E. (1985). Exploitation of coral reef fishes for the aquarium trade. Marine Conservation Society, 4 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, UK, 121 p.
- WOOD, E. (1992). Trade in tropical marine fish and invertebrates for aquaria. Proposed guidelines and labelling scheme. Marine Conservation Society, 4 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU, UK, 35 p.



Wild-caught juvenile reef-fish for farm growout: more research needed on biology and fisheries

by R.E. Johannes

The Sabah workshop on reef-fish aquaculture, discussed on page 37 in this issue, has highlighted the need for accelerated research on the biology of the late larval and early post-settlement fish of species important in the live reef-fish trade, and of fisheries for the latter. Published information on how, when, where and what species of wild juveniles can be caught to supply reef-fish farmers in the region is sparse.

A quick and relatively inexpensive way to get vital portions of this information would be to interview fishers who specialise in catching reef-fish juveniles for growout. They possess much valuable knowledge concerning seasonality, habitat preferences, and year-to-year trends in abundance of the targeted fish in their waters—information often largely unknown to researchers.

Some may dismiss such information as 'anecdotal', but the fishers who possess it depend upon it for their livelihoods. Information obtained from small-scale

tropical fishers can be highly informative, reliable, and invaluable to researchers and industry (e.g. Johannes, 1981). Often, moreover, such knowledge cannot be obtained by conventional biological research without the expenditure of a great deal of time, money and effort.

For example, large numbers of juvenile specimens of the panther or mouse grouper, *Cromileptis altivelis*, one of the most highly valued species in the live reef-food-fish trade, are captured for growout by fishermen in Indonesia (H. Sanger, pers. comm.). Yet the scientific literature yields no information concerning the kind of habitat preferred by the juveniles of this species.

We should be asking appropriate fishers and middlemen throughout the region what species can be supplied as juveniles in large quantities from the wild, as well as where and when are they most accessible and what local catch trends have been in recent years. A

synthesis of such information could provide the live reef-fish-farming industry with a regional overview of fish-farm stock supplies and greatly assist in future planning and more efficient deployment of resources.

Local methods for catching these fish also need more study. To attract juvenile reef-fish, growing numbers of fishers employ a variety of artificial habitats, such as the **gangos** of the Philippines (Ogburn & Ogburn, 1994) and the **temarang** of peninsular Malaysia (Ali & Ali, in press) and 'brush parks' in Sri Lanka. Studies on artificial habitat that provides shelter for juvenile groupers indicate that it greatly increases survival rates rather than simply concentrating them (e.g. Beets & Hixon, 1994; Teng & Chua, 1979.)

Such artificial habitats, if properly understood, might be exported to appropriate habitats in areas where such fisheries do not presently exist, such as Papua New Guinea and Irian Jaya, to provide new sources of employment for coastal villagers. Fishing for juvenile reef-fish requires extremely low capital investment (US\$ 27 per family in one such fishery in the Philippines examined by this writer). It thus offers an important source of employment for the poorest segment of coastal societies.

There are reports of dwindling supplies of wild juveniles in some areas (e.g. of *Epinephelus akaara* and *E. coioides* in Hong Kong and the adjacent waters of mainland China, as well as other grouper species in warmer waters). But research has seldom, if ever, documented these declines nor established the cause(s). Is it overfishing of the juveniles, overfishing of the adults which produce the juveniles, habitat degradation and pollution or a combination of these? Or is it an artefact of the great natural interannual variation in recruitment that is known to occur in a variety of species of reef-fish?

The rapid growth in the quest for juveniles of tropical fishes and invertebrates for farming requires much research if stocks are to be exploited and managed effectively. One obvious need is for reassessment of legal size limits. If wild-caught juveniles are to be used legally for farming, then size limits—in countries where they exist—must be adjusted accordingly. This may not prove to be a trivial task if it is done in such a way as to limit collection of small individuals to those to be used for farming, while preventing the collection of 'undersize' individuals for direct consumption.

Research described by Dr Vincent Dufour at the Sabah workshop suggests that if we harvested late-stage pelagic larvae instead of post-settlement juveniles, this could enable us to catch more juveniles for farming while having less impact on subsequent adult wild stocks. Making this idea commercially attractive would require considerable additional research, however.

To encourage the construction of artificial habitats for juvenile reef-fish, government resource managers also need to understand something of the social and economic dynamics of the relevant fishing communities.

For example, fishers should be assured the right to protect their artificial habitats from poachers and destructive fishing practices. Without this right they have little incentive to build them or protect those that are built for them.

Where such rights are in effect, fish aggregating devices (FADs) can, moreover, provide the impetus for improved, locally-based marine conservation. That is, they may stimulate a proprietary and protective interest in surrounding fishing grounds, with a consequent decline in destructive practices such as fishing with explosives and poisons (e. g. Galvez, 1991).

In summary, if reef-fish farming is to achieve its full capacity to exploit sustainably the large and fast-growing demand for live reef food fish, then greater efforts must be made to investigate the biology of, and fisheries for the juveniles that are—or could be—caught for growout. There will be little incentive for the industry—which is composed of innumerable small competing units—to fund such research. This would therefore seem to fall logically to governments, regional agencies and/or large NGOs.

References

- ALI, H.M. & A. ALI. (in press). Status report on aquaculture of coral reef-fishes in Peninsular Malaysia. **In:** Proceedings of the Workshop on Aquaculture of Coral Reef-fishes and Sustainable Reef-fisheries, 4–8 December 1996, Kota Kinabalu, Sabah, Malaysia.
- BEETS, J. & M.A. HIXON. (1994). Distribution, persistence, and growth of groupers (Pisces, Serranidae) on artificial and natural patch reefs in the Virgin Islands. *Bulletin of Marine Science* 55: 470–483.
- GALVEZ, R.E. (1991). Some socio-economic issues in artificial reefs management: a case study of Lingayan Gulf, Philippines. *Tropical Coastal Area Management*. April/August: 6–7.
- JOHANNES, R. E. (1981). Words of the lagoon: fishing and marine lore in the Palau District of Micronesia. University of California Press, Berkeley. 245 p.
- OGBURN, D.M. & N.J. (1994). Intensive pond culture trials of the green grouper (*Epinephelus malabaricus* Bloch et Schneider) in the Philippines. **In:** Chou, L. M. et al. (eds.) The Third Asian Fisheries Forum. Asian Fisheries Society, Manila, Philippines. 74–77
- TENG, S.-K. & T.-E. CHUA. (1979). Use of artificial hides to increase the stocking density and production of estuary grouper, *Epinephelus salmoides* Maxwell, reared in floating net cages. *Aquaculture* 16: 219–232.

