The "C.A.R.E." (collect by artificial reef eco-friendly) system as a method of producing farmed marine animals for the aquarium market: An alternative solution to collection in the wild

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Nature does things well

Life cycle

Most marine animals undergo a planktonic larval phase in their life cycle. This period of development, which for coral reef fish generally takes place in the open sea (oceanic) environment, is followed by return to the original habitat of the breeding stock of the species concerned. The oceanic larval phase duration varies from 10 to 100 days depending on the species of fish (Wellington and Victor 1992). This return is first passive, as dictated by the movements of water masses and ocean currents, thus favouring the dispersal of larvae, and then active for a short period (less than one week), during which time the larvae seek the reef habitat that will suit them best. This nocturnal (to diminish the risk of predation) phase, during which colonisation occurs, is a crucial phase in recruitment. It is only after this stage that the animals are called juveniles (associated with a change of diet, colour and sometimes shape) (Doherty and Williams 1988).

High mortality through natural predation

The various stages (from egg to juvenile) of the life cycle of these reef animals are marked by high natural mortality, mainly due to predation. It has been scientifically demonstrated that more than 90 per cent of the post-larvae disappear in the week following initial colonisation (Planes and Lecaillon 2001).

But nature in her providence enables female coral reef fish to produce more than 1 million eggs during each spawning event. Depending on the species, spawning may take place once per year or as frequently as every fortnight, such as in the case of the clownfish. The purpose is that at least two individuals of breeding age survive to ensure survival of the species.

Phototropism of post-larvae

Various scientific studies have shown that the majority of the oceanic ichthyoplankton is phototropic, or attracted to light. This characteristic, common to many marine animals, is also specific to fish larvae. Even more surprising is the fact that this characteristic disappears once the young fish has settled in (Leis 1991).

Conclusion

If larvae are collected before the intense predation event that occurs during colonisation, the impact of collection is negligible because the captured animals are part of a large pool of individuals, most of which are destined to become meals for lagoon predators.

Eco-friendly collection by C.A.R.E.

The many advantages of this new technique

ECOCEAN / ECOMAY has developed a new collection device, C.A.R.E. (collect by artificial reef eco-friendly). This new C.A.R.E. device, which is associated with collecting, sorting, weaning and growing procedures, is INPI-patented (Institut National de la Proriété Industrielle). Our need to protect the design of the device prevents us from sharing some of the design features in this article. ECOCEAN manufactures C.A.R.E. in France. C.A.R.E can be purchased by research centres or private partners for less than USD1000 (please email us for more information).

The C.A.R.E. device is illuminated at night with a waterproof lamp emitting a special spectrum. It is not only a trap; it is a lighted artificial reef. Post-larval fish spontaneously enter the cod-end of the device because they want to protect themselves from predation. The latest design was tested, improved and then compared with other post-larvae collection systems for more than one year in the Indian Ocean, where we have experimented with a pilot post-larvae collection farm. These devices are being used to collect post-larval fish in Florida and New Caledonia and have also been tested in French Polynesia and the China Sea. They have been designed and optimised with produc-

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tion in mind. Some of their advantages are described below.

1. The collected post-larvae are alive and have no surface abrasion. This is very important because most existing collection systems damage the animals, considerably increasing the risks of pathological reaction. This is especially true for plankton nets and crest nets. The algae (e.g. *Turbinaria*) that grow on collection devices and constantly brush against the larvae, the violence of the strong incoming currents, and the action of predators and sunshine near the surface all increase the stress experienced by the animals. With C.A.R.E., the post-larvae spontaneously opt to move to the inside of the artificial reef present in the water column, with neither stress nor physical contact.

2. There is no seaweed inside the receptacles and this facilitates the next stage of sorting. This is different from other larvae collectors, which sometimes harvest more algae than animals!

3. Certain models of C.A.R.E. will avoid catching pelagic species, such as Clupeidae (sardines) and Engraulidae, which are typically not wanted. Most other light traps catch these pelagic fish, which then die rapidly, as they need to be constantly moving. Sometimes more than 2000 dead pelagic fish are found in a light trap.

4. A C.A.R.E. system can easily be set from a boat in order to optimise collection and watch over the devices at night (as many as 10 C.A.R.E. can be deployed in a string, depending on the speed of the surface currents). If the devices are to be anchored, a five-kilogram brick is sufficient. The devices can be installed and uninstalled very quickly (e.g. in preparation for approaching storms).

5. Lastly, these collection devices are ergonomic for the user, easy to deploy, and inexpensive to transport. The total weight of a C.A.R.E. device is less than seven kilograms.

Negligible impact on the environment

It is very important to emphasise that the C.A.R.E. devices only collect phototropic post-larvae and that these post-larvae are collected just before intense natural predation, as explained above. The C.A.R.E. devices primarily collect post-larval finfish (all the families have already been collected), but they also collect crabs, prawns, cuttlefish and sometimes octopus if these animals are recruiting at the time and place of collection.

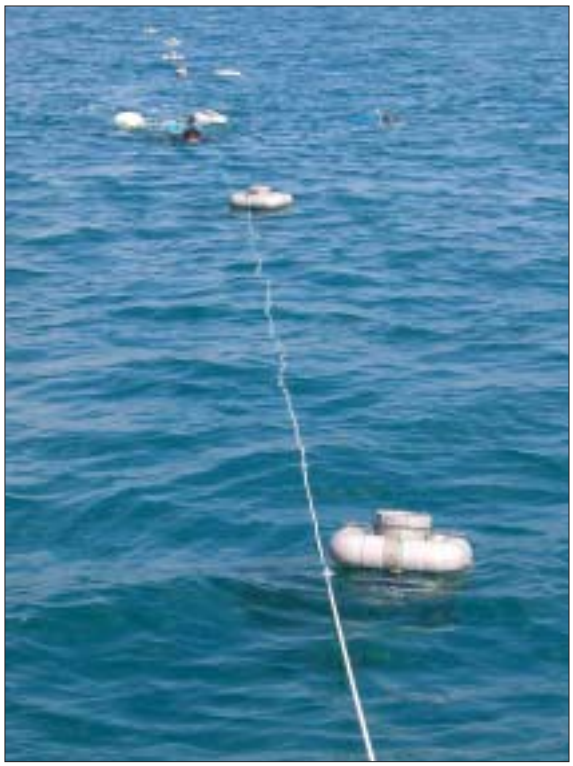

Figure 1. A string of C.A.R.E. devices (© ECOMAY/ECOCEAN).

As an example, if we were to collect 1000 post-larvae nightly from an island where several million post-larvae recruited daily, this would represent a negligible impact (less than 0.05%) on the natural stock. This impact is even more negligible if it is compared to that of direct collection from the breeding stock in the natural environment.

The environmental benefits of the C.A.R.E. system are therefore threefold: eco-friendly larvae collection, protection of the adult stock targeted by traditional fishing methods, and conservation of coral ecosystems.

Some fish grow-out operations start with very small juveniles rather than post-larvae. This method is very different than post-larvae collection because collection takes place *after* the period of intense predation, rather than *before*, so the environmental consequences are quite different.

Rearing marine animals

Juvenile and adult coral fish are often very colourful and therefore very highly regarded in the marine aquarium market. This rapidly developing market requires and implies major collection activities in the wild to meet the high demand. In order

to avoid uncontrolled collection, farming would appear to be the only solution.

Status of the activity

Fish

At the present time, only a tiny proportion of all tropical marine fish species are bred artificially. Approximately 50 species of the 1000 used for marine aquaria (5%) are reproduced in captivity. Many of these are reared only on an experimental basis — they are not produced and marketed on a large scale. The most popular commercialised fish species are the clownfish, followed by the *Pseudochromis* (dottybacks) and certain cardinalfish, together with some gobies and blennies. It should be noted that some food fish are also bred in captivity. The ratio is reversed for freshwater aquarium fish, in which case there is a clear predominance of farming over collection in the wild.

Invertebrates (other than corals)

Giant clams are bred in many places but only a few companies market them consistently. Other invertebrates, such as shrimps, particularly *Lysmata wurdermanii* (peppermint shrimp) and *Lysmata seticaudata* (Monaco shrimp), and a few others, are reproduced in captivity.

Corals

An increasing number of hard and soft corals are being farmed, or more precisely, propagated, but few ventures are as yet really profitable.

Live rock

Lastly, cultured "live rock" is reaching the market from various places. The attractiveness and richness of the product is determined by the amount of time the rock is left in the water to build up growth of various organisms (from one to ten years). Cultured live sand also exists. These two products are used both as decoration and for filtration in marine aquariums because of their anaerobic component.

ECOCEAN: A new approach to eco-friendly fish

Various larval collection techniques have been experimented with, including plankton nets, crest nets, and channel nets, but these techniques often have the drawback of wounding the animals during capture. Indeed, the original idea behind designing the C.A.R.E. devices was to avoid having any contact between the larvae and anything else during capture, during sorting, or during the following stages of farming. The grown-out fish, having been carefully attended to for more than six months in some cases, is "domesticated," robust, readily eats inert food and is ready for transportation. The result: a farmed fish guaranteeing a very high survival rate!

In the course of developing the C.A.R.E. system, we met professional fish farmers in various countries, established partnerships, and introduced a logistical system enabling us today to offer a unique range of farmed marine animals with a high quality label.

These farmed fish (from eggs or post-larvae) should be considered as an "eco-friendly" product, as they have been carefully produced over a longer time with care and under the guidance of a clear and strict quality charter (ECOCEAN®). But, producer, importer and distributor must agree to reduce their profit margins in order to play the game and produce a final cost acceptable to the consumer, bearing in mind the quality offered. This aspect of the trade in farmed marine organisms — the costs associated with producing eco-friendly products — is an important one and worthy of further discussion, but it is not addressed in detail here.

Figure 2. Example of new farmed species, butterflyfish (© ECOMAY/ECOCEAN).

Practical solutions

The problems encountered by some countries exporting wild animals for the aquarium market could be rapidly resolved by the solution described here. It is easy to say that overfishing and damaging techniques such as cyanide fishing must be stopped, but indigenous people need other economic avenues and not just prohibitions.

Countries that regulate or simply ban the collection of marine animals for the aquarium market could look to other job-creating activities, such as the

farming of wild-caught post-larvae. To this end, we are working in conjunction with international non-governmental organisations but also with locally based organisations. ECOCEAN/ECOMAY often works with scientists such as those from the University of Perpignan in France and the University of California at Santa Cruz in the USA in order to validate the results obtained during our research and to appraise the consequences.

Some governmental environment departments are preparing to amend their laws to make these plankton collection activities for rearing marine animals possible and accessible. This is the case with the Service des Pêches et de l'Environnement Marin (SPEM) on Mayotte Island in the Comoros, Indian Ocean, as well as the Florida Fish and Wildlife Conservation in the USA.

The greater the diversity of farmed species that is available on the market, the more consumers will focus on farmed animals, and the more the environment will be protected. This is why ECOMAY/ECOCEAN is today trying to obtain permission to work in and collect specimens from other potentially beneficial sites.

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Figure 3.
Aquaculture technician, Mayotte Island, Comoros.