Aquafarmer Information Sheet

Farming Soft Corals for the Marine Aquarium Trade

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Introduction

Total world retail value of the aquarium industry in 1995 was estimated at between 4 and 15 billion $U.S. with plant and animal sales alone estimated at 900 million $U.S. The United States, Japan and the member states of the European Union are currently the world's largest importers and consumers of aquarium livestock. It is estimated that there are 10-20 million aquarium enthusiasts in the United States alone. Marine species make up only 9% of the volume of the aquarium pet trade but due to their high value represent 20% of livestock revenues. The keeping of marine aquaria, especially the so-called "**reef tanks**" which contain live corals, is a rapidly growing sector of the aquarium industry. This expansion is primarily attributed to recent advances in technology that now allow corals and other marine invertebrates to thrive in home aquariums.

Most soft corals found in marine aquariums are collected from the wild. However, the high value of marine tropical fish and invertebrates has led to a sometimes ruthless exploitation of reef animals in developed and developing countries alike. This fact, in conjunction with increasing concern over the negative effects of activities such as logging, dredging, oil drilling, human habitation and destructive fishing practices, has led to a trend of protective legislation for coral reefs worldwide. Many tropical Indo-Pacific nations have now banned or restricted the collection of aquarium specimens from their waters and are encouraging sustainable aquaculture of these animals. Soft coral farming is a simple technology that provides an excellent income-earning opportunity for the coastal-based populations of the U.S. Affiliated Pacific islands.

Why farm soft corals?

Given that soft corals are an excellent way to earn income, the following list outlines other advantages to growing soft corals as opposed to other marine invertebrates:

1. Soft corals occur in many different colors and shapes making them attractive additions to a marine aquarium. In addition, soft corals have an ability to constantly change form by expansion or deflation of the body and retraction or extension of their polyps. This lends a dynamic aspect to coral reef tanks.
2. Most of the commonly cultured soft corals are photosynthetic and do not have to be fed. This makes them easier to maintain in an aquarium setting than their non-photosynthetic counterparts that have to be fed. With correct lighting and minimal dissolved nutrients, soft corals can thrive for years in a home aquarium.
3. The hardiness displayed by many species of soft corals enhances their potential as farmed corals, because of their ability to survive handling stress during planting and shipping. In addition, these animals survive well in reef tanks making them excellent specimens for beginners and experts alike.
4. The primary form of reproduction in soft corals is cloning (**asexual budding**). Taking advantage of this trait, farmers have developed fragmentation techniques where a fragment of soft coral is removed from the parent colony to form a new colony.
5. Relatively fast healing times and high growth rates in cultured soft corals allow a harvest time of only 4-12 months. This can be a great benefit to farmers in allowing high inventory turnover and an early return on investment.
6. Soft corals have a high value per unit weight which makes shipping cost-effective from remote areas such as the U.S. Affiliated Pacific islands, where air freight is expensive and cargo space is often limited.
7. At the time of publication, only a few soft corals are listed under the Convention on International Trade in Endangered Species (CITES). This eliminates the need to obtain certain permits and costly inspections involved with shipping other corals.
8. Soft coral farming does not need to be a full-time occupation. Once fragments are cut and successfully planted they require very little tending until harvest.
9. Capital start-up costs of soft coral farming are generally quite low.

Biology

Soft corals are colonies of small animals known as polypoid cnidarians (shortened to polyps). These polyps rarely exceed 5 mm in diameter and are arranged in soft, fleshy, irregularly shaped colonies of up to 1 meter in size. Each polyp has 8 tentacles which are **pinnate** (Figure 1), and are

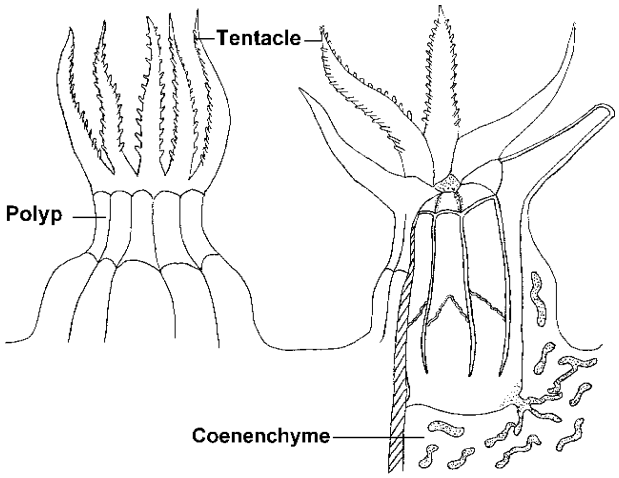

Figure 1. Schematic diagram of a soft coral polyp.

embedded together as a colony in a mass of tissue called the coenenchyme which is fed and maintained from the gut of the polyps and covered by a protective skin. The colony grows through asexual budding and consequent formation of coenenchyme around the new polyp. Special organs, called amebocytes, secrete calcium carbonate **spicules** in the coenenchyme which give rigidity and support to the colony. Spicules differ in shape and size with each genus and are used to identify different soft coral species.

Many soft corals are well-suited for aquaculture because they derive a large portion of their nutrition from a **symbiotic** relationship with millions of **photosynthetic** algae called zooxanthelle (*Symbiodinium microadriaticum*) that live in their body. While zooxanthelle produce mainly complex sugars, they can also produce **amino acids** and **fatty acids**, a portion of which are released through the algal cell wall directly into the body of the soft coral. The direct benefit of this symbiotic relationship to coral farmers is that soft corals can be grown through their entire life cycle with clean seawater and sunlight as the only sources of input.

Some commercially valuable soft corals

Listed below are brief descriptions of some soft corals regularly found in marine aquariums. More comprehensive details of these and other cultured soft corals can be found in the manual titled "The culture of soft corals (Order: Alcyonacea) for the marine aquarium trade" which is listed in the resource section of this publication.

Sarcophyton or mushroom corals (Figure 2) are the hardiest and easiest soft corals to grow. They are extremely abundant in the tropical Pacific Ocean, often occurring in high energy areas such as surge zones and tide pools but are also found in deeper water. Like nearly all cultured soft corals, *Sarcophyton* possess zooxanthelle and generally have a beige, olive, brown, green or light yellow color. They have a smooth base containing no polyps which is covered by a crown which houses the zooxanthelle and polyps, giving the colony the shape of a large mushroom. The crown may be lobate or undulating to increase surface area, especially in larger specimens. Polyp size, shape and color can vary quite dramatically between species making them attractive additions to home aquaria.

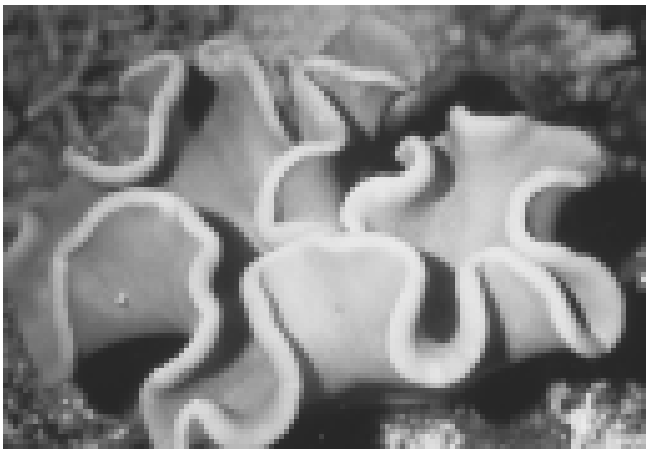

Figure 2. Sarcophyton spp.

Sinularia (Figure 3) are like *Sarcophyton* because they have a nearly polyp-free column which differentiates into a polyp-bearing area. However, *Sinularia* have a more branch-like (arborescent) or bushy appearance. They are one of the most morphologically diverse groups of leather corals and can easily be confused with other soft coral genera. They are found mainly on rocky substrates and hard gravel of lagoons and reef fringes throughout the tropical Pacific. All *Sinularia* studied have zooxanthelle and are therefore relatively easy to keep in the marine aquarium.

Nephthya (Figure 4) and *Lithophyton* (Figure 5) are quite similar and are often called tree corals. All these animals have a similar, arborescent appearance with spiculose

Figure 3. Sinularia spp.

Figure 4. Nephthya spp.

Figure 5. Lithophyton spp.

Figure 6. Cladiella spp.

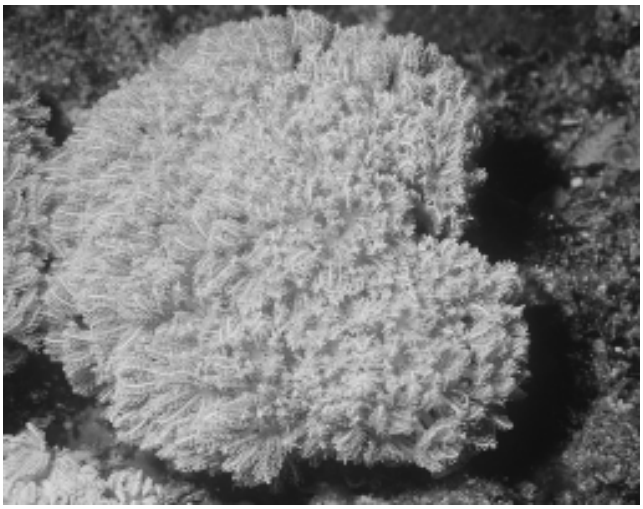

Figure 7. Xenia spp.

polyps. Colors are generally the brown, beige and cream hues associated with photosynthetic soft corals. They are found mainly on reef slopes or coral rubble with strong illumination and high water flows.

Cladiella (Figure 6) and *Sinularia* often look very similar and are easily confused. *Cladiella* have a similar branching structure to *Sinularia* with the same polyp-free stem leading to polyp-bearing branches or lobes. Their body color generally varies from creamy white to light brown and they are usually photosynthetic with dark polyps. These corals are usually found in deeper water on the outer reefs, fore reefs and deep lagoons.

Xenia or waving hand corals (Figure 7) are characterized by large, non-retractable polyps that often pulse. All tropical species are photosynthetic and have the characteristic beige, cream or brown color of their symbiotic zooxanthelle. *Xenia* are widely occurring but are often associated with shallow, fast-moving water.

Basic farm requirements

The following provides a basic checklist of needs that must be considered when starting a soft coral farm.

Suitable ocean site

Many areas of the U.S Affiliated Pacific islands are characterized by large, sheltered, pollution-free lagoons that are perfect for soft coral farming. Even islands that have limited lagoon areas usually have deeper holes and depressions where farming can take place. A typical farm site would be located in 1-5 m of clear ocean water and should be away from point sources of pollution such as dredge sites, garbage dumps, marinas and sewage outfalls. Soft corals prefer full strength seawater and will quickly die if exposed to brackish water or freshwater for long periods. For this reason sites should be located away from freshwater sources such as river mouths. Light is important for coral growth and only mild water cloudiness can be tolerated.

A good water exchange rate is important for bringing fresh nutrients to the corals but this must be balanced against providing adequate shelter for the corals during storms. Ideal sites are those that are close to reef islands or located on the back side of barrier reefs in sand or coral rubble areas. These sites provide some protection from wave action but also have a good water exchange. Depth is also an important factor to consider when placing a farm site. Shallow sites are easier to work on but are more likely to be damaged during a storm.

A final and extremely important factor to consider in farm siting is security. Throughout many areas of the U.S. Affiliated Pacific islands, anything left unattended in the water is considered public property and can therefore be taken. Sites should be chosen that are close to the farmer's house or to people who are willing to watch over the farm.

Water transport

The degree of remoteness of the farm site will dictate what kind of water transport is needed. A small boat, raft or canoe may be sufficient for sites close to the farmer's house and land. More remote farms may require a bigger boat with a larger motor. A larger boat may also be needed to collect and transport broodstock (see next section).

Broodstock corals

Broodstock are the corals from which cuttings are removed to start new colonies. They should always be the finest specimens available and chosen for good color, shape and health. Farmers may need to travel some distance to find good quality broodstock which can then be transported back to the farm site for cutting.

Equipment

Aside from a boat, the most expensive equipment necessary will be **SCUBA** diving gear. While not always necessary, SCUBA equipment allows the farmer more flexibility in collecting broodstock and choosing farm sites as deep areas may not be readily accessible by free diving.

Other equipment is minimal and includes trays, gravel, hammers, chisels, knives and mesh bags.

Land-based holding facility

A land-based holding facility is simply a covered area with tanks where corals are held for up to one week prior to shipping. This is not always necessary if corals are being sold directly to a local wholesaler who will take care of exporting the animals. It is also not necessary if the corals can be brought in from the farm and held in clean, shallow seawater close to the shore. In this way, corals can be easily brought ashore and packed for shipping. In some areas, pollution and freshwater runoff prevent corals from being brought close to shore in this manner. If that is the case, then a land-based holding structure is necessary.

Farming techniques

Farmed soft corals are reproduced using a natural process called **fragmentation**. The often turbulent environment in which soft corals live has led to an adaptation whereby dislodged or fractured corals can reattach to a new substrate. Farmers exploit this natural process by fragmenting broodstock colonies and replanting them to form new colonies. Fragmentation or cutting techniques follow a similar format. A piece of the parent colony is removed using a sharp knife or pair of scissors. If the cutting is properly removed, it will heal and form a new colony similar to the parent. The following rules apply to all forms of fragmentation:

1. A sharp razor knife, kitchen knife or pair of scissors should be used for cutting.
2. The parent colony and cuttings should be handled gently to prevent internal injury and bruising. Whenever possible, parent colonies should be held by the substrate to which they are attached.
3. All cutting should be done under water.
4. The cutting or parent should not be exposed to air for long periods of time.

Cuttings are then planted on a gravel substrate to which they attach over a period of 1-2 weeks. The substrate is usually any readily available aggregate product, such as basalt or coral rubble, which is submerged at the ocean farm site. Farmers can use a boundary structure such as nursery trays, PVC pipe frames or mesh baskets to keep the aggregate in place or they can simply lay the aggregate on the ocean floor. Care should be taken not to lay aggregate over living coral areas.

After planting and attachment occur, the corals require very little maintenance other than periodic site visits to check on growth rates. The time frame from planting to harvest is generally 6-18 months. This depends on factors such as the size of the original cutting, the species used, the target harvest size and other environmental factors.

Economics

The economics of soft coral farming is affected by many variables such as farm location, its size and target market. It must be noted that operating costs and expected profits will vary greatly within the region. The simple, hypothetical example presented below assumes the following:

1. The land-based facility is located in a rural or low cost area of Micronesia.
2. Land area is coastal and is approximately 300 m in length.
3. There is a production goal of 2,000 pieces per month requiring a production rate of 125 cuttings planted per

dive hour. Accounting for mortality, this would require 5 diving days per month for 2 divers.

4. The farmer conducts 2 broodstock collection dives per month.
5. The average sale price of each piece of coral is $2.
6. All prices are in U.S dollars.
7. The farm is operated by a single owner who takes salary from the profits.

The company's costs on a yearly basis might be as follows:

Land lease ($300 per month)	$3,600
Construction of land-based holding facility ($10,000 @ 5 year depreciation)	$2,000
Electricity	$1,200
SCUBA gear for 2 people ($1,000 @ 5 year depreciation)	$ 200
Tank fills (14 fills per month @ $5 per fill)	$ 840
Used pick-up truck ($4,000 @ 15 year depreciation)	$ 800
Boat and motor ($10,000 @ 15 year depreciation)	$2,000
Fuel (6 gallons per day, 7 days per month)	$1,008
Staff member (quarter time at $3.00 per hour)	$1,440
Miscellaneous expenses	$1,000
Computer ($2,000 @ 5 year depreciation)	$ 400
Marketing materials and communications	$ 800
TOTAL	$15,288

Gross revenue = $48,000 (2,000 pieces per month @ $2 each)

Profit before taxes = $48,000 - $15,288 = $32,712.

Break-even point for this model = 637 pieces per month.

Although costs such as labor, tank fills and fuel increase with the amount of corals exported, the fixed costs such as depreciation, land leases and electricity remain the same. Therefore, profit increases greatly with increased production. For example, taking into account the increased costs of fuel, tank fills and labor, increasing production from 2,000 pieces per month to 2,500 pieces per month would increase profit before taxes to $43,608. Increase in total operating costs is only $1,104 to produce the additional 6,000 cuttings.

Eventually the land-based facility, near-shore farm sites and boat will reach a carrying capacity and fixed operating costs will increase at that point. Time spent packing and shipping will also increase substantially, even though the buyer covers these costs.

Marketing

Marketing is one of the most challenging aspects of soft coral farming. Soft corals are an export product sold directly to wholesalers for use as aquarium specimens. The simplest way for a farmer to market corals is through a local wholesaler who deals in aquarium fish or giant clams. The farmer will receive less money per coral but will not have to deal with the packing and permitting aspects of exporting corals. If this option is not available, then corals must be shipped to the buyer in plastic bags containing water and pure oxygen. Full details of shipping procedures are described in the manual "The culture of soft corals (Order: Alcyonacea) for the marine aquarium trade" listed in the resource section of this publication.

Wholesalers want to buy corals that are hardy, colorful and cheap and it is important to select corals for the farm that fit the wholesaler's requirement as closely as possible. Cultured coral products are sold in direct competition with wild collected animals from around the Indo-Pacific. These are generally collected cheaply and have a wide variety of colors and shapes. Some conservation-minded home aquarists will search out a cultured product and pay a premium for it. A benefit of cultured corals is that they are often better cared for than the wild collected animals, which are usually taken from the environment and exported almost immediately. Cultured corals are more easily moved and generally suffer less stress during harvest and shipping.

One of the easiest ways to find buyers today is via the internet. Many wholesalers advertise in aquarium magazines and most now have e-mail addresses. A farmer can simply prepare a stock or product list and e-mail it to potential buyers. A simple website with pictures of the corals is also an excellent marketing tool. Where internet access is still not widely available, marketing efforts can be made in more traditional ways. The best traditional method for advertising the farm's products is a simple brochure with a few pictures of the product, a product list and accompanying price list. The price list should not be printed directly on the brochure because the brochure may last for many years but prices constantly change.

Further information

This information sheet is designed to give only basic information on farming soft corals. Before starting a farm, it is important to contact the local marine resource department to seek technical assistance and to ensure that any existing local laws on marine leasing and export are adhered to.

CTSA, Hawaii Sea Grant and the College of Micronesia Land Grant program operate an aquaculture extension network designed to provide information and assistance in all forms of tropical aquaculture. They can be reached at the following addresses:

Regional Aquaculture Extension Agent, COM Land Grant, P.O.Box 1179, Kolonia, Pohnpei, FM 96941. Tel. 691-320-2728, Fax 691-320-2726, e-mail: sellis@mail.fm.

CTSA, The Oceanic Institute, 41-202 Kalanianaole Hwy., Waimanalo, HI 96795, USA. Tel. 808-259-7951, Fax 808-259-8395, e-mail:clee@teligentmail.com.

University of Hawaii, Sea Grant Extension Service, 2525 Correa Road, HIG 237, Honolulu, HI 96822, USA. Tel. 808-956-2873, Fax 808-956-2858, e-mail: rbailey@hawaii.edu.

Resource materials

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Amino acids - the basic components of protein.

Asexual budding - a form of reproduction where a soft coral polyp forms an exact replica of itself without releasing gametes.

Fatty acids - one of the basic components in fats or lipids.

Fragmentation - the process by which small pieces are taken from a parent soft coral to form a new colony.

Photosynthesis - the ability to convert sunlight into energy.

Pinnate - having feather-like side branches.

Reef tank - a home or commercial closed system tank display, designed to replicate life on coral reefs. These generally contain soft and hard corals, fish, live rock and other invertebrates.

SCUBA - Self Contained Underwater Breathing Apparatus (SCUBA) a diving apparatus where all the equipment needed for breathing underwater is attached to the diver, including a tank containing pressurized air.

Spicules - calcium carbonate structures which help support soft coral colonies. Occurring in different shapes and sizes, spicules are used to speciate soft corals.

Symbiotic - a biological relationship between two organisms that is mutually beneficial.

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