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Ogo sporeling growout using line culture technology.

Culturing "Ogo" in Ancient Hawaiian Fishponds

There are many rural communities along the nation's 95,000 miles of coastline which would be ideal candidates for NCRI investment, but there are few regions which are in greater need of the Institute's assistance than the island of Molokai in the Hawaiian chain. Molokai has the highest proportion of native Hawaiians of all the islands except Niihau. Most of these native Hawaiians are rural coastal residents who face an erosion of their traditional lifestyle and economic base. Unemployment is high, job skills are relatively low, and marine/coastal-based employment opportunities are severely limited. Tourism on Molokai is not well developed yet, and those jobs that are available in the tourism industry often involve long daily ferry rides to Maui. Increased on-island job opportunities which are suited to the resources and lifestyles of Molokai's 7,200 rural inhabitants are desperately needed.

One potential employment opportunity lies in the commercial culture of edible seaweed. There are many different varieties of both indigenous and non-native consumable seaweeds in Hawaii, however *Gracilaria*, a macroalgae, is the most heavily cultivated for commercial purposes. Two of the most popular types of *Gracilaria* are *G. parvispora* ("long ogo" of Japan) and *G. coronopifolia* ("limu manuea" of Hawaii). "Limu" is the Hawaiian word for plants that grow underwater, therefore both of these species are synonymously referred to as limu on the islands. Formerly abundant on Hawaii's reefs, these edible species of limu have been overharvested to the point where they are only occasionally available for sale.

A limu aquaculture industry would be vital to Hawaii's economy because the wild populations of *Gracilaria* which have supplied the

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world's markets have been overexploited, and current aquaculture forces have not been able to meet the increasing demand. This represents a unique opportunity for island entrepreneurs to participate in an emerging new aquaculture market. At present, the yield from a single 1-hectare limu farm could provide local residents with 5-20 metric tons of seaweed with a production value ranging from $5,000 to $20,000.

In 1990, NCRI funded the University of Arizona's Environmental Research Laboratory, in partnership with the Ke Kua'aina Hanauna Hou, a charitable and educational non-profit corporation which develops and implements community-based economic programs on Molokai, to help introduce *G. parvispora* ("ogo") culture to the island. This potential cash crop could be raised, initially, in Molokai's traditional man-made fishponds and ultimately, on the surrounding reef flats where sufficient siltation and water motion provide a conducive culture environment. Eventually, this could represent a new cottage industry opportunity for the people of Molokai and, eventually, throughout the Pacific islands and at other tropical locations.

Harvest size ogo grown from sporeling on coral chip.

(**Note:** NCRI is also funding work on *G. coronopifolia* culture on Molokai. This work will be detailed in a subsequent issue of *NCRI News*.)

There are 58 ancient fishponds along Molokai's southern shore having a combined surface area greater than 200 hectares. The fishponds were originally constructed by Hawaiians who walled in portions of the fringing coral reefs with rocks. "Makahas", which served as control gates, were placed in strategic locations around the pond to permit sufficient tidal water exchange. The physical conditions of the island's fishponds have deteriorated significantly over time due to heavy siltation, the encroachment of mangrove trees, and the breaching of the retaining walls by the relentless surf. Restoration of the ponds has been undertaken by some native Hawaiian groups but the process is painstakingly slow and costly.

The initial phase of this project was designed to demonstrate the feasibility of culturing *G. parvispora* in this fishpond environment. Basically, this involved four key steps:
1) expanding ogo production capacity;
2) optimizing culture techniques (water motion and nutrient level experiments) and

determining optimal culture substrates to increase ogo growth rates; 3) reducing labor requirements associated with ogo culture; and ultimately, 4) constructing and operating a working hatchery, nursery and growout system for ogo culture.

After three years of considerable trial and error, these objectives were successfully achieved and a preferred methodology and protocol for growing ogo in a predictable, stable culture system was developed. This "preferred" method started with the collection of cystocarp-bearing (cystocarps are masses of spores formed as a result of fertilization), mature thalli (a vegetative plant body) which were subsequently placed in a hatchery. The thalli were collected either from wild populations on the reef flats or cultured material from selected, productive Molokai fishponds. This hatchery phase lasted approximately 2-3 days and was carried out in land-based, aerated tanks of filtered seawater. Lines or other substrates such as small rocks or coral chips were immersed in the tanks where fertile thalli were present. Spores released from the cystocarps readily attached themselves to the substrates.

In developing this methodology, ongoing experiments continued to define, refine, and re-define the optimum amount of fertile material required per volume of tank, the best placement of substrates in the tanks and other variables. In 1993, a pilot hatchery began operation at Puko'o Pond on Molokai, producing 1,200 - 2,400 spore-coated rocks and chips per week, as well as spore coated lines for outplanting and growout in the Puko'o Pond and for distribution to a growers network on Molokai for outplanting and growout in other ponds.

Growout consisted of placing the substrates into suitable locations in fishponds. The definition of "suitable" depended upon the type of substrate. Rocks or chips coated with spores were placed on the fishpond bottom in trays or broadcast directly onto the bottom. These plantings developed harvest-size plants in approximately 20 weeks in areas of high water motion, but in areas of lower water motion, the rocks and chips tended to become covered over by sand, thus inhibiting the growth of the spores. On the other hand, spores growing on lines suspended between stakes grew rapidly even in areas of low water motion. Harvest of lines began 20 weeks after spore set by clipping back the ogo and allowing it to regrow for subsequent harvests at four to six week intervals. After a certain period of time, the ogo eventually became too fouled (by silt, sand, and epiphytes) to continue productive growth and thereby had to be replaced. As the accompanying photos indicate, growout of cultured ogo spores on substrates such as rocks, coral chips and lines proved to be extremely successful.

With these proven culture methods and protocols in hand, the next phase of this project was to transfer the technology to the interested island residents through a series of demonstration and training workshops. This insured that seaweed culture would become an economic reality by seeking out additional coastal residents to become growers, training prospective growers in culture techniques, assisting the growers in obtaining leases on ponds, and creating a marketing cooperative.

Outreach activities undertaken to document and disseminate the ogo culture information included: refining a business plan, preparing an operations manual for hatchery, nursery, and growout methods and protocols, conducting training sessions and workshops for public and aquaculture extension workers, preparing instructional videos on hatchery and growout techniques, preparing a photographic atlas of ogo production, and preparing articles for publication in refereed scientific journals and making presentations at scientific meetings.

This project has demonstrated that there is a strong market potential for cultured ogo and an equally strong local community interest in taking the lead role in developing this burgeoning, albeit fledgling, industry. It is now possible to envision, in the near future, a number of seaweed farms operated by local cooperatives which are supplying fresh, traditional ogo for local restaurants and supermarkets. Perhaps those same farms will serve as the basis for a colloidal seaweed industry for export markets. Already, Molokai ogo is being sold to restaurants and hotels in Maui and is also being used in value-added products such as "Molokai Limu Salsa", which has potential for off-island and mainland sales. At the very least, this project, and the successful partnerships forged from it, offers Molokai's coastal residents an opportunity to make a living from the sea while maintaining their local, traditional lifestyle.