Screwing up equals smartening up:
Starting an in-house rearing program at the Cockrell Butterfly Center

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INTRODUCTION

In October of 2012, budgets were tight at the Cockrell Butterfly Center (CBC). We needed to find a way to cut costs and increase revenue. We turned our efforts to bringing back a large scale butterfly rearing program that had once been implemented years back. Selling pupae would be an additional source of income and raising our own butterflies would allow us to cut importation expenses. At the same time, the USDA was making changes to restrict the importation of native species from international sources. This was another factor that favored having an in-house rearing program. On top of all this, the museum had been working on expanding current outreach programs, which was putting a strain on current staff members. In three years the museum increased presentations from about 45 presentations a year to over 100. Having an additional staff member was sorely needed. All these factors contributed to the conclusion that reviving the rearing program and hiring a new Butterfly Rearing Coordinator would be incredibly beneficial. This decision embarked us on an occasionally painful but ultimately rewarding journey.

RESEARCH

In order to effectively create a proposal for our administration, we had to do a little more research. Using online databases, internet sources, and Butterfly Boutique's electronic manuals, we were able to get a host plant list and an idea of improved rearing methods. For example, a great way to improve sanitation is using popup mesh cages rather than more permanent rearing cages. These popups are used once and then bleached to aid in the reduction of caterpillar pathogens. They are also great because you can easily store them when they are not in use.

The biggest help was the data from a larger rearing program that had been in place before all of the involved staffs' time. We found research materials, notes, host plant lists, production data, and even detailed instructions for a few species that were previously reared in the facility. From those records, we were able to determine what we thought were reasonable and attainable goals for production and sales revenue.

COCKRELL BUTTERFLY CENTER DATA

1994-2003

The production of pupae started slow in the second half of 1994 with a total of 431 chrysalids produced between August and December. As the CBC's popularity grew, so did the success of the rearing program. Pupae propagation was possible year round with the greenhouses outfitted with heaters but as expected, spring and summer months were still the most productive. A total of eleven species were being raised but a big portion of the total was made up of *Dryas iulias* and *Heliconius charitonius*. The most successful year was 1996 with a yearly pupae production of 25,107. The average monthly production between 1994 and 2003 was 1,550 pupae. To bring in additional revenue, an average of 6000 pupae was sold to other butterfly exhibitors each year.

2004-2008

Between 2004 and 2008 the average monthly pupae production dropped to 1200 per month. The variety of species increased to 16 but the primary species produced (90%) remained *D. iulias* and *H. charitonius.* During this time period eight customers bought pupae from the CBC and sales averaged about 3000 pupae a year.

2009-2012

In 2009 our staff member layout changed. With the new staff's primary responsibilities lying in growing and raising plants and maintaining the greenhouses, the CBC rearing program fell by the wayside. Production levels fell and were kept at a low but steady rate of about 250 pupae per month. We slowly stopped selling pupae and kept the small number we raised for use in the CBC. The main species still remained *D.iulias* and *H. charitonius* with occasional *Heliconius eratos* and *Danaus plexippus* in the mix.

PROPOSAL

We set out to create a proposal that a belt-tightening administration would have a hard time saying "no" to. We listed the previous reasons as to why we needed to hire an extra staff member and then set out a budget containing expenses, goals, and expected revenue. There would be no chance of success unless we completely offset the cost of hiring a new employee and supply costs.

Current Assets

Since a small rearing program was already in place, we were lucky in having most of the supplies and facility space that was needed. The Cockrell Butterfly Center was added to the Houston Museum of Natural Science in 1994. In addition to the three-story indoor butterfly exhibit and entomology hall, three 100 square meter greenhouses were built on the top level of the parking garage. These greenhouses were designated for growing and storing additional plants for the butterfly center and for housing a rearing program. One greenhouse was designated as the "propagation house". This is used for propagating by seeds, cuttings, and also stores many of our plants that replenish our conservatory and are used in plant sales. The second greenhouse is our flight house. Our flight cages and pupation cages are kept here as well as a few plants used in the program. This greenhouse is connected by a screened vestibule to our third greenhouse to adhere to USDA regulations. It is dedicated to contained plant recovery after they have been consumed by the very hungry caterpillars.

Our flight cages (1.5m x 1m x 2.4m, LWH) are constructed of metal screen and were updated in 2004 from PVC and netting cages of similar size. There are screen doors connecting the cages in sets of two. These doors can be opened to create (4) 3m long cages. Water hoses and misters were installed in each cage to increase humidity and avoid creating spaces for butterflies to escape while plants are being cared for. The sliding doors are obstructed by a PVC strip curtain that aids in containment when staff is entering and exiting each flight cage. There are (6) 1 cu m and (1) 3 cu m pupation cages constructed of mesh and recycled rubber-decking material. There are an additional 4 pupation cages constructed of the same material as the updated flight cages that are .75 cu m each.

Expenses

The biggest expense, obviously, was hiring an extra full-time staff member with benefits. We also proposed a 5% increase in our soil budget, costs for 40 mesh popups, plants, butterflies, shipping supplies and research materials. We played with our expenses until we came to amount that we thought would be easily offset by the new program.

Revenue and Goals

To immediately relieve the sting of spending money we added our goals and expected revenues. We figured we could offset our importation by 20% and add revenue by selling our surplus to other exhibitors. We also had the idea, which was never pursued, to sell in-house releases for weddings, etc. We also added that this new staff member could help us expand our outreach program as well as act as a back-up presenter for outreach programs in other departments.

PROGRAM RESSURECTION

First Month

In our first month (December 2012), our supplies were bought. This consisted of research materials (books, seminar material, etc.), cleaning supplies, and 40 mesh-pop-ups of varying sizes. Plant propagation was put into overdrive and so was egg collecting. We also experimented with several species with known host plants in our stock. We quadrupled our pupae output to just under 1000 chrysalids! However, towards the end of the month we realized we were running out of plants. We slowed egg collection but the damage had already been done.

Ooops….

Through January and February we had to deal with a depleted plant stock. While during the spring passion vine bounces back fairly quickly, it did not dawn on us that during the winter regrowth is very slow. We had butterflies, but no plants to feed the caterpillars. Caterpillars that had hatched late in the previous month were culled in mass numbers. It was a depressing time and changes had to be made.

Changes

We had a small variety of plants with small surpluses in each species. We vamped up propagation even more than we had in the past. December taught us an important lesson: less is

more. Just because you can get your butterflies to lay 1000 eggs doesn't mean you should. We were experimenting and finding ways to estimate how many plants we needed to reach the goals we had set in our budget. Reality finally set in.

PROBLEMS

Plant Pests

When you cram thousands of organisms into a tight space, you create a breeding environment for problems. Balancing high production levels with quality, healthy "products" is a tough thing to do. Plants become more susceptible to pests such as aphids, scales, mites, mealy bugs, thrips, and whiteflies. Since you are using your plants to feed other insects, pesticides are not usable. Safe solutions include safer soap, sulphur, adding beneficials to your greenhouse, and cutting back heavily infested plants. We've had an issue with rats eating our milkweeds of all things. The best thing to do is put out rat traps or baits.

Diseases and Parasites

Your caterpillars are also more susceptible to diseases and parasites when there is little space. Researching caterpillar diseases can make you want to cry. There are thousands of bacterial, viral, and fungal diseases that they can come down with. If you are planning on raising monarchs *Ophryocystis elektroscirrha* (OE) will always be your biggest concern. This is a well known protozoan parasite that can wreak havoc on any rearing system. Almost all wild adults carry OE so it is often recommended to purchase rearing stock from a reputable breeder rather than wild collecting. One OE spore can quickly spread and will cause you to start from scratch. There is a lot of great research material out there about how to keep OE out of your green houses. We simply cut back our milkweed after each feeding and make sure to keep sanitation to the highest standards.

Predators and Parasitoids

When you have a collection of hundreds or thousands of caterpillars you are almost guaranteed to attracted parasitoids and predators. Luckily, we have only had flies from wild collected specimens and have never had to deal with braconids or chalcids. However, predators are another story. Yes, we get the occasional red wasp or cute little jumping spider, but our biggest problem lies with ants. We have a constant battle with many species of ants but mainly those of the fire, crazy, or ghost variety. They love to steal eggs and 1st instars and attack pupating or fresh chrysalis. Insect-a-slip and moats (bowls of water around table legs containing rearing cages) have proven to be very successful when used in conjunction with ant traps and baits.

SUCCESSES

2013 Production

Especially considering early setbacks, our first year of production was very rewarding. We fell just short of our yearly goal of 24,000 pupae with a total production of 23,399 including over 25

species. We also increased our propagation to holding 1500 plants exclusively for rearing. However, we missed our sales goal by 50% due to unrealistic expectations and the fact that we did not start selling until the middle of the year. But, we successfully cultivated numerous regular customers as well as 25 different species available for sale as well as flight in our own center. Considering this was the pioneer year for this program, we were very satisfied with our success.

2014 Production, YTD

At the beginning of the year we set more attainable targets and as of mid-July, we are about 10% ahead of our goals in pupae production and sales. We decreased our species list to closer to 20 to better manage plant propagation and storage of those plants. We currently have about 2000 plants solely dedicated for the rearing program. We would love to propagate more but have found that we are out of space. We are looking into other programs such as hydroponics to increase our plant production.

Species Currently Produced

Below is a table listing our currently raised species and the host plants that we commonly use and have been found to be the most productive for us. Many of the breeding stock is wild collected but quite a bit of it is purchased from different suppliers throughout the United States, but primarily Florida and Texas. We also have an example butterfly garden on our grounds containing various host plants and nectar plants. In a pinch, we gather caterpillars from there if we can find them.

Common Name	Scientific Name	Host Plants Currently Used
Gulf Fritillary	*Agraulis vanillae*	*Passiflora caerulea*
White Peacock	*Anartia jatrophae*	*Ruellia spp.*
Great Southern White	*Ascia monuste*	*Cleome spp.*
Atlas Moth	*Attacus atlas*	*Cinnamomum camphora*
Pipevine Swallowtail	*Battus philenor*	*Aristilochia fibriata*
Queen	*Danaus gilippus*	*Asclepias currasavica*
Monarch	*Danaus plexippus*	*Asclepias currasavica*
Julia Longwing	*Dryas iulias*	*Passiflora biflora, P. yucatenensis*
Glasswing	*Greta oto*	*Cestrum spp.*
Zebra Longwing	*Heliconius charitonius*	*Passiflora biflora, P. yucatenensis*
Rice Paper	*Idea leuconoe*	*Parsonsia spp.*
Buckeye	*Junonia coenia*	*Plantago spp.*
Red Bordered Pixie	*Melanis pixe*	*Pithecellobium dulce*
Green Birdwing	*Ornithoptera priamus*	*Aristolochia triloba, A. tagala*
Giant Swallowtial	*Papilio cresphontes*	*Ruta graveolens*
Black Swallowtail	*Papilio polyxenes*	*Foeniculum vulgare*
Spicebush Swallowtail	*Papilio troilus*	*Cinnamomum camphora*
Sulphur Spp.	*Phoebis spp.*	*Cassia spp.*
Malachite	*Siproeta stelenes*	*Ruellia spp.*

A list of current butterflies that we commonly produce and their associated host plants.

ADVICE

There is a long list of limiting factors with any rearing program. The most important are plants, space, and money. If you have unlimited money, you can have unlimited space and therefore unlimited plants. It is also important to practice patience while you are starting up your program. It takes time to grow plants and grow a customer base. Raising 24,000 butterflies in house is great, but remember: you can only do a limited amount of species. You have to balance your importation with your in-house rearing. You must also keep in mind seasonal conditions. Even in a greenhouse, you are going to have a hard time rearing the same number of pupae in December that you did in June.