Butterfly Farming in the East Usambara Mountains

Research Report

Findings to date from research covering the periods form November 2001 to October 2002 and from February 2003 to October 9, 2003.

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Summary

This report documents the findings to date of my butterfly farming research and the progress of the Amani Butterfly Project, which was started in the summer of 2002 by the Tanzania Forest Conservation Group based on my research. Initially, I received support from the US Fulbright Fellowship program to carry out this research. For the year 2003, I have received research support from the African Rainforest Conservancy, which is based in New York City.

This report is dived into two main parts. The first part describes everything that I have learned regarding butterflies, host plants, and equipment needed for butterfly farming in the East Usambara Mountains. The first part of the report also describes questions that still remain to be answered, such as unknown host plants and possibilities for improved farming techniques.

My research since November of 2001 has yielded a great deal of information regarding butterfly farming. Here are some of the highlights.

- Specific information regarding host plants for farming over 30 species of butterfly.
- Partial information regarding farming of another 30 butterfly species.
- Detailed information regarding host plant gathering and care.
- Detailed information regarding techniques and equipment that are appropriate for farming butterflies in the East Usambara Mountains.

The application of my research by The Tanzania Forest Conservation Group has helped start the Amani Butterfly Project. This project is expected to sell over $60,000 USD in butterflies every year with 65% of earning going directly to local farmers in the East Usambara Mountains and another 7% going into a development fund for villages involved in butterfly farming. The project will therefore provide local farmers with a direct economic incentive to preserve forests near them for butterfly habitat and as a source of host plant seedlings. Future research may examine the strength of such an economic incentive.

The second part of this report describes the startup experience of the Amani Butterfly Project. There are many valuable lessons learned while creating this project regarding how best to organize people and empower communities to participate in their own development. The final organizational structure of Amani Butterfly Project is a good example of a way in which government agencies and NGO's can involve local people directly in conservation and development projects. Also, the experience the project has had working with different government agencies may be valuable to people looking to start similar projects that combine development and conservation issues.

Part 1: Butterfly Farming in the East Usambara Mountains

1) Important Butterfly Species

The East Usambara Mountains are home to around 400 species of butterfly[1]. However, only some of these species are suitable for butterfly farming and live export. Generally, buyers in the live exhibit market prefer butterflies that are large, colorful, and active. Butterflies that fly too fast, like the genus Charaxes are not popular with the live exhibit market, but can be very popular with the dealers in dead stock who have similar preferences for size and color, but are not concerned about behavior.

My butterfly research since November of 2001 has focused on seasonality, abundance, and life history information relevant to farming 65 species of butterflies and 4 species of day flying moths from the family Arctidae. I arrived at this list of 65 butterflies using *Butterflies of Tanzania* by Jan Kielland, which gives locality data for all the species it describes. It was assumed that all the species in the Amani area worth farming had already been described since they would be large and attractive species.

1.1 General Seasonality and Abundance

Every species of butterfly in the Amani area is affected by seasonality. This ranges from being present every single month of the year, but at varying abundance, to being present for only two or three months a year. For butterfly farming this information is used to determine which species will be reliable to produce for the live exhibit market, which is also seasonal and strongest between March and October each year. In addition, knowledge of seasonal patterns of abundance can be used to determine if there are any unexpected affects from butterfly farming on wild populations.

To examine seasonal abundance, I created a series of walking transects. The transect walker used a checklist to record each individual butterfly seen or caught in hanging fruit traps. This data was taken from December of 2001 to July of 2002, after which resources were focused away from the time and labor consuming transects. Once intensive farming begins, a more limited system of transects comparing areas where butterfly farming is allowed an d those where it is not, will be used to monitor for any unexpected effects from butterfly farming.

The initial survey did reveal some interesting results that indicated good potential for a successful butterfly-farming project in the Amani area. Species of the genus *Papilio*, which are very popular with the live exhibit market, are available year round and seem to be abundant around the time of peak demand from the live exhibit market in March, April and May.

A few types of butterfly, most notably species belonging to the genus *Graphium*, are very seasonal and will likely only be possible to farm for a few months each year, centering around the long and short rains when conditions are sufficiently warm and humid. The *Graphium* do not migrate but rather enter diapause and stay in their pupae until weather conditions are appropriate to emerge.

[1] Personal communication from Norbert Cordiero, an East Usambara Mountains butterfly expert. No definitive survey or list for the entire East Usambaras exists.

Since the end of walking transects in 2002, general observation and experience while actively butterfly farming has shown that seasonality in the Amani area is strongly affected by elevation. In the cold months of June, July and August, the abundance of almost all butterfly species seem to decline at elevations higher than 600 meters. At this same time, at elevations below 600 meters, butterflies remain numerous. This trend seems to continue until September, when temperatures begin to rise again and the forest below 600 meters begins to dry. In the months of January and February, very few butterflies can be found below 600 meters, but many important species continue to breed at higher elevations.

In terms of butterfly farming, the seasonality and abundance patterns of butterflies in Amani seem to indicate that butterfly farming will be seasonal for many species of butterfly. In practice, this means that butterfly farmers at lower elevation will farm more during the cold months and less during the dry months. For butterfly farmers at higher elevation the situation is reversed. Artificial manipulation, such as moving pupae to a lower elevation and then bringing up adults that emerge from pupae can extend the farming season at higher elevation to include the cold months, though the process is slower and yields are slightly lower. Similar manipulations may work at lower altitudes as well to continue breeding in January and February. At any rate, a butterfly-farming project in the Amani area is not expected to suffer from extreme seasonality that will limit exports at a particular time of the year since lower production at one elevation can be offset by higher production at another elevation.

1.2 Reproductive Ability of Captive Butterflies

Thorough data regarding life histories for each individual species has not been kept due to time constraints. However, many observations have been recorded and are sufficient to make generalized descriptions of the life histories and reproductive ability of different types of butterflies.

Most wild caught female butterflies have already been impregnated. Butterflies from pupae that mate in fly cages begin to lay eggs within a day of mating for the first time. Therefore, it can be assumed that most female butterflies caught in the wild have already begun to lay eggs before they were caught. This fact, combined with the shock of being captured and placed in a small 4x4 meter cage, helps to explain why many wild caught butterflies fail to lay large numbers of eggs in captivity. For the genus, *Papilio*, this varies from 20 to 60 eggs over the span of a week or two depending on the weather conditions and the age of the butterfly. Butterflies from the family Nymphalidae are not as sensitive and can still generally lay a good number of eggs after being captured. One *Hypolimnas antevorta*, caught while it was probably only a couple of days old, laid over 500 eggs in captivity over a period of 30 days. Two wild-caught *Charaxes pollux*, laid near 1200 eggs in 6 weeks. Other shorter-lived Nymphalidae such as *Danaus chrysippus* lay between 100 and 200 eggs after being captured depending on their age and the weather.

Fortunately, second generation butterflies that emerge from farmed pupae, tend to lay far greater number of eggs in captivity. An individual *Papilio ophidicephalus* from pupa can lay between 10 and 30 eggs a day for 3 weeks after mating only once. Individual *Papilio nireus* from pupa, which lay much smaller eggs than *ophidicephalus*, can lay between 20 and 60 eggs a day for nearly a month after one mating.

The fertility of eggs varies and generally, large eggs have a higher hatching success, but this is not always the case. The primary causes of eggs not hatching are neglecting to collect them before parasitoid wasps infect them, exposing them to excessive moisture, or letting them dry out. Inbreeding can also lower hatching success. If these problems are avoided with correct farming techniques, 75% to 100% of eggs will hatch depending on the species of butterfly.

The percentage of larva reaching the pupa stage is also variable depending on farming technique. The most common mistakes are exposing the larvae to spiders, predatory wasps, parasitoid wasps, or neglecting to move the larvae when they have finished their host plant. It is also easy to lose larvae if they crawl out of their cage to make their pupae. If these problems are avoided, 85% to 100% of larvae will reach the pupae stage.

As long as the pupae are well protected from parasitoids and the larvae were also well protected, 95 to 100% or pupae will produce healthy adults.

Thus in captivity, the reproductive ability of butterflies is astonishing. Consider the reproductive ability of *Papilio ophidicephalus*, a species that does not lay large number of eggs in comparison to other species that the project is farming. Using proper farming technique, under the worst conditions, one older wild caught female will lay only 20 eggs. Using the lowest survival ratios for each life stage, we would expect these 20 eggs to result in 12 healthy adults, only six of which would be female (20 x .75 x .85 x .95 x .5). However, even in poor weather, most female *P. ophidicephalus* from pupa can lay at least 250 eggs in their lifetime. If proper farming techniques are used and these six females are crossed with wild males, in the worse case scenario the third generation will produce 900 healthy adult butterflies. 450 of these will be female. The fourth generation from these 450 females would consist of over 68,000 healthy adult butterflies. The average generation time for *P. ophidicephalus* is 42 days, so after catching one wild female it would take around 6 months to arrive at 68,000 healthy adult butterflies if sufficient food is available.

The reproductive capacity of butterflies in captivity clearly shows that after establishing captive butterfly populations based on a few females, butterfly farmers will only need to occasionally add wild males to their populations to insure good genetic diversity. Therefore, there is virtually no impact from butterfly farming on wild butterfly populations.

1.3 Generation Time

- Eggs – Depending on the species of butterfly and the weather conditions, butterfly eggs take 5 to 10 days to hatch in the Amani area.

- Larvae – Depending on the species of butterfly and the weather conditions, butterfly larvae take 14 to 25 days to form pupae in the Amani area.

- Pupae – Depending on the species of butterfly and the weather conditions, butterflies take 5 to 20 days to emerge from their pupae if they do not enter diapause. After entering

diapause, some species of butterfly can take up to 3 months to emerge from pupae in the Amani area.

- Adult – In general, *Papilionidae* are shorter lived than members of *Nymphalidae*. In captivity, *Papilionidae* live for 3 to 4 weeks. *Nymphalidae* live from 4 to 8 weeks.

- Generation Time – In total, generation times from egg until adult range from 25 days for *Acraea egina* to 43 days for *Hypolimnas antevorta*.

1.4 Host Plant Research

Since November of 2001, there has been a steady accumulation of relevant life history information for the potentially farmable species. This information was gathered from field observations, literature, breeding experiments, consulting botanical experts, and from local butterfly farming experience.

Kielland's Butterflies of Tanzania and Larsen's Butterflies of Kenya, both provide lists of recorded host plants (usually just the genus, not species of plant) for most of the butterfly species they describe. A small number of species did not have a known host plant record. These lists tend to be thorough for the species for which host plant information is available. In practice, experience in Amani has shown that while larvae will often eat most of the listed host plants under captive conditions, females will often only lay on one of the types listed. In a couple of cases, records seem to be completely incorrect. Breeding experience has shown that larvae bred on the female preferred host plant generally grow larger, produce bigger pupae, and consequently larger adults.

Field observation and unknown larvae rearing has been especially useful for locating host plants used by day flying moths whose larvae are conspicuous, which is fortunate since their host plant records are non-existent. In a number of instances host plants for butterflies were located by watching females laying eggs in the wild.

Butterfly farmers involved in the project have located a few host plants themselves through field observations and by rearing unknown larvae. This has led to host plants for one day flying moth, *Catopsillia florella*, and *Belenois thysa*.

The botanical experts consulted were Mr. Mndolwa and Mr. Iddi who work for the Tanzania Forest Research Institute. They were particular useful in locating and identifying some of the host plants listed in the guidebooks.

The final method for locating host plants was to plant all the available species of a particular plant family, for instance Rutaceae, and then to let female butterflies choose their preferred host plant in shade net cages. Many kinds of butterflies can use multiple members of a particular plant family, but females may prefer a particular species in the family for laying.

1.5 Species Specific Information

Note: For adult foods, if not specified, assume flowers.

1.5.1 Family Arctiidae:
No species names are known for these day flying months since a guide is difficult to locate. Instead, the project has developed common names that apply to each species.

- Irridencent Blue and Orange – Apparently feeds on *Deinbollia burbonica* according to the Fanusi farming group. It is usually not seen above 400 meters.

- Tiger Stripe – Feeds on *Crotolaria* found along rivers and roads. This species is not common but mostly seen after the cold season is over at altitudes from 900 meters to 600 meters.

- Forest – Feeds on *Brucea* species. It is common year round in Amani between 800 and 1000 meters, though it can occationally be seen as low as 600 meters.

- Red and Black with White Spots – Food plant not known, but may be species of small shrub/herb that Arctiidae larvae have been found on in the past. James Msuya also knows the plant.

1.5.2 Family Hesperiidae:

- *Coeliades chalybe* – An iridescent blue skipper. No attempt to breed it has been made. It is most active in the early morning and at dusk. It is found from 300 meters to 900 meters. Kielland reports *Cynanchum* as a host plant.

1.5.3 Family Nymphalidae:

- *Acraea aganice* – A large *Acraea* species that will lay on the common species of *Adenia* in Amani. It is mostly found along rivers from 500 meters up to 900 meters. Shipping pupae may be difficult since the pupa phase lasts from 6 to 7 days.

- *Acraea satis* – Another large *Acraea* species with interesting translucent patches on the wings. No attempt has been made to breed this species, but females have been witness apparently laying eggs on a species of *Rinorea* found along rivers in the Amani area, where the butterfly species is most commonly seen. *Rinorea* is listed in Kielland as a host plant for *satis*.

- *Acraea egina* – Another large *Acraea* species found in more open areas. It is readily bread on Adenia. The pupa phase is around 5 days so it may be hard to ship live.

- *Amauris niavius* – The largest *Amauris* species in the Amani area and a very popular model for mimetic species. The host plant was located through observation of a female in the wild. The unidentified vine, which must belong to the Asclepiadaceae family, surprisingly does not produce latex. In warm weather, females readily lay eggs on this vine in shade net cages. This species went from being one of the most commonly seen species in 2002 to almost non-existent in the first half of 2003. This decline was not noticeably seasonal and was likely caused by a large parasite population. The population

seems to be rapidly recovering in the second half of 2003. It occurs from 400 to 1000 meters.

- *Amauris ochlea* – Similar to *Amaris niavius* but smaller. It occurs from 300 meters to 900 meters. A specific Asclepiadaceae has not been located for this species. However, the Mlola butterfly-farming group has found its larvae feeding on the same unidentified vine as described for *Amauris niavius*. Unfortunately, females refused to lay eggs on the vine in shade net cages. It is usually present throughout the year but is not as common as *niavius*.

- *Amauris albimaculata* – Another popular model, this species is seasonal and reaches its greatest abundance in the cold months of June and July. It is seen from 300 meters to 900 meters. The correct Asclepiadaceae has not been located, but is likely found in open grassy areas where this butterfly flies. The genus *Tylophora* is a likely candidate.

- *Aterica galena* – This species seems to be available most of the year but responds to rainfall. It is seen from 300 meters to 1000 meters. Its host plant is apparently *Deinbollia burbonica* and its larva and pupa are almost exactly the same as *Euphaedra neophron*. This species is fond of narrow forests paths and never flys more than a foot or two above the ground. Problems with its pupae in shipping are likely since it is so closely related to *Euphaedra neophron*, which usually fails to emerge if shipped. Some experts believe this is due to changes in humidity. Adults feed on fermenting fruit but seldom enter traps.

- *Bebearia orientis/chriemhilda* – These species apparently both occur in the East Usambara Mountains from 500 to 1000 meters. It often difficult to differentiate the two and not much work has been done with either species so they are listed together. They should use a species of *Phoenix* or related palm, but it is not clear what they might use at the higher elevations where no palms grow. These species also often fail to emerge after shipment. Adults feed on fermenting fruit but seldom enter traps.

- *Catuna sikorana* – Another low flying trail species like *Euphaedra*. One attempt to get eggs on *Bersama abyssinica* failed, but this is still the best guess for a potential host plant. It is found as low down as 500 meters but seems most common along trails at 800-900 meters. Adults feed on fermenting fruit but seldom enter traps.

- *Charaxes acuminatus* – A large, slower and lower flying *Charaxes*. Host plant has not been specifically identified but likely candidates are *Allophylus*, *Bersama* and *Deinbollia*. It is found as low as 400 meters and up to 1000 meters. It is most common immediately following the rains and in the cold months of June and July. This seems to be the case for most *Charaxes*. It is the Amani area's most common *Charaxes*. It can be trapped with fermenting bananas.

- *Charaxes brutus* – A medium sized, fast flying canopy *Charaxes*. Occurs throughout the Amani area. Larvae suspected to be *brutus* were found on Trichilia dregeana, but unfortunately were lost in transport. Probably follows the usual *Charaxes* seasonality. It can be trapped with fermenting bananas.

- *Charaxes candiope* – A medium sized, fast flying canopy *Charaxes.* Females readily lay eggs on *Croton megalocarpsis*. Follows the usual *Charaxes* seasonality and is found anywhere there is *Croton*. It can be trapped with fermenting bananas.

- *Charaxes cithaeron* – A larger, fast flying canopy *Charaxes*. Females have been witnessed laying eggs high in the canopy of an *Albizia* tree. One attempt to get a female to lay eggs on an *Albizia* seedling failed. This species is found wherever *Albizia* occurs and follows the usual *Charaxes* seasonality. It can be trapped with fermenting bananas.

- *Charaxes etesipe* – A medium sized, fast flying *Charaxes*. It is reported to use *Cassia* but no attempts have been made to breed it yet. It occurs from 300 meters to 1100 meters. It can be trapped with fermenting bananas.

- *Charaxes lasti* – Medium sized, fast flying *Charaxes*. Not attempt to breed this species has been made. It is found at any altitude and may use *Afzelia* and other Fabaceae. It can be trapped with fermenting bananas.

- *Charaxes macclounii* – Smaller, fast flying *Charaxes.* Uniquely, this species uses species of bamboo for host plants. No attempt has been made to breed this species. It can be trapped with fermenting bananas.

- *Charaxes pollox* – Large, fast flying *Charaxes*. This species is readily bread on *Bersama abysinica* and free flying females have no trouble finding the host plant in shade net cages. This species is one of the most common *Charaxes* in Amani and is found from 1100 meters to 600 meters. It can be trapped with fermenting bananas.

- *Charaxes protoclea* – A medium sized, fast flying *Charaxes*. This species almost certainly breeds on *Afzelia*. It is particularly common in the upper portions of the Kambai Forest Reserve. No attempt to farm it has been made. It can be trapped with fermenting bananas.

- *Charaxes usambarae* – A medium sized *Charaxes* that is fond of hill topping. Males will often chase swallows mistaking them for other males. This species is endemic to Tanzania and is only found in a few northeastern mountains in addition to the Usambaras. Kielland reports the host plant to be *Albizia*, but no attempts to farm it have been made. It is commonly found on open hilltops in the Amani area around 900-1000 meters. It can be trapped with fermenting bananas.

- *Charaxes varanes* – A medium sized *Charaxes* similar to *acuminatas* but smaller. It seems to occur along rivers and generally at altitudes below *acuminatas*. No attempt to breed it has been made, but *Allophylus* seems to be a likely host plant. It can be trapped with fermenting bananas.

- *Charaxes violetta* – A medium sized *Charaxes* that closely resembles *cithearon*. No attempt to breed it has been made. It occurs from 500 meters to 1100 meters. It can be trapped with fermenting bananas.

- *Charaxes xiphares* – A gigantic *Charaxes* that is very popular with collectors. No attempt to breed it has been made. It is not a common species and has only been trapped on Mbomole Hill and near the Amani Nature Reserve Headquaters. It can be trapped with fermenting bananas.

- *Cymothoe amaniensis* – Apparently endemic to the Usambara Mountains. In Amani it is frequently found on Mbomole Hill. No attempt to breed it has been made. Another possible *Cymothoe* species is apparently quite common at times in the lower parts of the Kambai Forest near the village of Msige.

- *Danaus chrysippus* – One of Africa's most common butterfly species. In Amani it occurs year round and will use just about any species of Asclepiadaceae. One of its favorite Asclepiadaceae is the vine *Dragea*. This species is found at any altitude. Larvae and Pupae may be subject to high rates of parasitism, though this had not proved a problem when raising larvae it in mosquito netting.

- *Danaus/Tirumala petiverana* – This species can be relatively common in Amani at high altitudes during the dry months of January and February, and at lower altitudes during the cold months of June, July and August. Not attempt to breed it has been successful. It should use an Asclepiadaceae species that occurs at forest edges. It does not use *Dragea* or the vine for *Amauris niavius*.

- *Euphaedra neophron* - This butterfly flies low along the ground and is found of forest roads paths. When warm enough, it can be seen as high as 900 meters but generally prefers around 400 to 600 meters. It can be very common after the rains in March. It is readily bred on *Deinbollia burbonica*. Pupae from this species frequently fail to emerge post shipping and alternative arrangements, such as shipping late stage larvae, may need to be made to make this species sellable for the live market. Adults Feed on fermenting fruit but will not enter traps.

- *Euphaedra orientalis* – This butterfly exhibits the same behavior as *neophron*. It never becomes very common in the Amani area and seems mostly to occur around 400 to 600 meters. No attempt to breed it has been made. Presumably, pupae from this species will suffer from the same shipping difficulties. Adults feed on fermenting fruit.

- *Euxanthe tiberius* – A large different looking butterfly that is related to *Charaxes*. It is easily bred on *Deinbollia Kilimanjarica* and *Deinbollia burbonica*. It occurs from 300 meters to 900 meters. It is found year round but is never very common. It can be trapped with fermenting bananas.

- *Euxanthe wakefieldi* – Not as large as *tiberius*, but similar looking. It is also readily bred on *Deinbollia burbonica*, but may use *Allophylus* as well. It is found year round but never

very common. It occurs from 300 meters to 900 meters but is most common around 400 to 600 meters. It can be trapped with fermenting bananas.

- *Hamanumida daedalus* – Common year round in disturbed areas. Flies very low along ground. Host plant not yet identified. Related to *Euphaedra*, so possible problems with humidity changes in shipping. Adults are attracted to fermenting fruit.

- *Hypolimnas antevorta* – Endemic to the East Usambara Mountains. Some unconfirmed reports from the West Usambara Mountains. Though it is seen every month of the year, it is most prevalent in August, September, and October at altitudes between 800 and 300 meters. Adults feed on mango. It is easily bread on Urera species.

- *Hypolimnas anthedon* – This species is common year round along rivers and roads from 900 meters to 300 meters and is an excellent mimic of *Amauris niavius* and *Amauris albimaculata*. Females will only lay eggs on the common *Laportia* species found in rocky areas. However, large larvae will migrate to any species of *Urera* once they have finished their *Laportia* food plant. Adults will feed on mango.

- *Hypolimnas misippus* – This species is very common in Amani at 800-900 meters in open areas during the months of January, February, and March. It is likely available at lower elevations at other times of the year. It uses a species of *Justica* that grows in open, grassy areas.

- *Hypolimnas usambara* – This gigantic species is very reclusive and as a result rarely seen in Amani. It may be more common in the Kambai Forest Reserve. It specializes on *Urera sansibarica* growing off of rocky cliffs or boulders, preferring to lay eggs at the ends of the growing tips. It has been seen from 500 meters to 800 meters, usually in dense forest. Adults likely feed on fermenting fruit.

- *Junonia oenone* – This species is common in Amani during the dryer months, though some can be seen year round in open grassy areas. It most likely uses a species of *Justica* or *Asystasia*, but no plant has been located yet. Found at all elevations in Amani. The pupa phase is likely very short at around 5 or 6 days.

- *Junonia terea* – This species is more of a forest edge species than *oenone*. It is common in Amani year round from 600 meters and up and lays on *Justica* and *Asystasia* growing along the forest edge. The specific plant has not been located. The pupa phase is also likely short at 5 or 6 days.

- *Precis octavia* – This species is small but seems to have sufficiently long pupae phase for shipping. It breeds on *Katange* (Kiswahili) a houseplant with green and maroon leaves that must be in the Lamiaceae family. Females also lay eggs on wild members of this family, but not as frequently. I have not worked out its seasonality but it seems to be found in the Amani area at all elevations in low numbers year round. Adults in captivity will feed on mango.

- *Pseudacraea boisduvali* – Females of this species are seldom seen and it may be easier to start a population from captured larvae. The larvae are easy to locate because they eat *Mimusops* in a particular fashion. They begin with the tip of the leaf and slowly eat back the leaf leaving only the central vein from which they hang when not feeding. Larvae cover themselves with debris. Males are seen most of the year along rivers and on top of Mbomole Hill. Adults in captivity will feed on Mango. This species occurs from 1100 meters to at least 500 meters.

- *Pseudacraea lucretia* – This species can be very common after the long rains in Amani from 900 meters to 300 meters. Its food plant is likely different species of *Chrysopyllum*.

- *Salamis anacardii* – This species is found in the Amani area up to 900 meters when the weather is very warm, but not common. It probably breeds on a species of *Justicia* or *Asystasia* found in open areas.

- *Salamis parhassus* – This species is found in Amani year round and can become very common along the Sigi River after the cold season. It is found from 300 meters to 900 meters. It is easily bred on *Brillantaisia,* and a large leafed species of *Asystasia* found in Amani. Adults in captivity love mango.

- *Salamis cacta* – This species is rare in the Amani area and mostly found around Sigi and along the Longuza forest road from 600 meters to 400 meters. Its food plant is reported to be *Urera*, but no attempt to breed it has been made. It is attracted to fermenting fruit.

1.5.4 Family Papilionidae:

- *Graphium angolanus* – A fast flying tailless *Graphium*. This species is mostly found in the lower Amani area, but frequents hilltops near the village of Makanya. Its food plant is *Annona senegalensis*. It is most common after the rains in March.

- *Graphium antheus* – No info

- *Graphium colonna* – No info

- *Graphium kirbyi* – No info

- *Graphium leonides* – A fast flying, tailless *Graphium.* This species is found at lower elevations after rain and periodically at elevation up to 900 m. It may be common in August and September in the Shambangeda forest. It is easily mistaken for *Danaus petiverana,* but flies much faster. James Msuya witnessed a female laying and collected an egg from a species of *Uvaria*.

- *Graphium philonoe* – No info

- *Graphium policenes* – A fast flying, tailed *Graphium*. It can reach very high densities in the Amani area during and immediately after the long rains, absent other months. Uses a

species of *Uvaria*, which can grow to be a small tree and is most common around 600 meters. Probably uses other species of *Uvaria* as well as it is found all the way up to 1100 meters.

- *Graphium polistratus* – No info

- *Papilio dardanus* – Very popular species with live exhibits. Males and females are very different. Females in Amani are very variable with at least 5 recognizable forms. This species can be found year round along the Sigi River. During the colder months it is not common above 700 meters. Females will lay eggs on the single – leafed species of *Vepris* found along the Sigi River, or on *Citrus*. Breeding larvae on any species of *Vepris* results in much larger pupae than *Citrus*.

- *Papilio demodocus* – This specie is found in Amani almost year round, except in the coldest month of July and part of August. It can be found at any elevation. Females lay on *Citrus, Zanthoxylum,* and *Vepris*.

- *Papilio desmondi* – This species is found in Amani at higher altitudes, generally above 800 meters, but occasionally down to 600 meters. It is very similar to *P. nireus*, but with a much larger blue band. It is a montane species and prefers ridge tops rather than rivers. The preferred food plant is likely either *Vepris* or *Toddalia*, though no attempt to breed it has been made.

- *Papilio echeriodes* – This species is common in Amani at higher elevations from 800 – 1100 meters, though may be found lower in the Kambai Forest. It is never very common but seems to be available most of the year. Thus far females have laid on *Citrus, Zanthoxylum, and Vepris*. *Citrus* seems to be preferred over the latter two.

- *Papilio hornimani* – In the Amani area, this species is found almost exclusively along the Sigi River. It is found year round at varying elevations along the river; preferring elevations below 600 meters when whether is cold. It reportedly breeds on *Vepris*, but this has not yet been confirmed. It seems to have trouble flying in shade net cages, and becomes tattered very quickly in comparison to other *Papilio*. Females are rarely caught in the wild.

- *Papilio nireus* – This species is found in Amani year round at varying elevations depending on the time of year. It is more common below 600 meters in the colder months. Females lay on *Citrus, Toddalia, Vepris, Clausena, and Zanthoxylum.* Larvae grow particularly well on *Toddalia.*

- *Papilio ophidicephalus* – A very large species if bred on the right host plant. This species is found year round along the rivers and sometimes roads in the Amani area at varying elevations depending on the time of year. Prefers below 600 meters in the cold months and then slowly begins to climb back up to 900 meters. Females lay on *Clausena* and *Zanthoxylum.* The larvae grow much larger if bred on *Zanthoxylum gilleti.*

- *Papilio pelodurus* – This species if found occasionally in Amani from 800 to 1100 meters. Males are found almost year round on Mbomole Hill, where females can also sometimes be seen. The food plant in Kielland is *Cryptocarya liebertiana*, which seems to make sense given the very large tree of this species on top of Mbomole Hill. One female refused to fly in a round shade net cage after being captured.

- *Papilio phorcas* – This species is usually not found outside of the forest. It does not appear to be an exclusively canopy species so it may fly well. It may be most common in the dry months of January and February, but it is difficult to tell given its reclusive nature. The food plant is likely *Vepris* or *Zanthoxylum*. I have not seen it below 800 meters.

1.5.5 Family Pieridae:

- *Belenois thysa* – A rapid flying member of the family Pieridae. Its host plant has recently been found and as of yet not identified. The pupa phase is likely short so shipping may be difficult. Occurs throughout the Amani area along roads.

- *Catopsilia florella* – A larger Pieridae that breeds on just about any species of *Cassia*. Careful records have not yet been kept but the pupa phase is likely short. Found throughout the Amani area in open areas.

2) Important Plants, Growing Techniques, and Quantities Required

This section gives information regarding the projects experiences growing different plants that are either host plants or important nectar sources for butterflies. Generally, plants grown from seed are much strong and grow faster. It is important to let the seedling reach a decent size, of say one foot or more before using it as a host plant. Whenever possible, larvae should not be allowed to eat all the leaves of a host plant.

2.1 Growing Techniques

- Soil Mix- The standard soil mix that seems to work for most of the host plants is two parts forest top soil (best if this includes some leaf litter and large organic debris) and one part fully composted cow manure (it is essentially black soil). Sand and lime can be added if this mix is too harsh for some plants or very small seedlings.

- Transplanting- Proper transplanting technique is essential. Transplanting from the forest is best done on rainy or overcast days in the morning or afternoon. The ideal location for locating good transplants is the border of the forest where vegetation is frequently cleared for cultivation or roads. Plants and seedlings should be dug up with a shovel or machete depending on which is most appropriate for the size of plant. The digger should make every effort to get as much of the roots as possible and to this end it is preferable to remove the plants together with the block of soil in which they were growing. To transport the transplants, it is useful to bring a large bucket with a handle. It is best to immediately put the plants into plastic tubes or plant where desired after digging them up. Placing the transplants in heavy shade for two days after transplanting can also help to

reduce shock, but then generally it is preferable to place them in an area where will get some sun.

- Germinating Seeds- The technique that has proved most successful for a wide range of seeds is to prepare a seedbed. The seedbed should consist of the soil mix described previously made into a slightly raised bed under clear plastic or some other protection from hard rain. Seeds should be cleaned of as much fruit as possible. The easiest technique is to peel off the skins and then mix the seeds with sandy mud and to scour them a little by working this mix between hands. Then, rinse the seeds clean with water. The project has found that seeds of all species should not be planted but rather pressed slightly into the seedbed and then either covered with a very thin layer of forest soil or forest leaf litter. Finally, the seedbed should be watered regularly, but creating mud should be avoided.

- Fertilizer- The best fertilizer is fully composted cow manure. Adding a half-inch layer of fertilizer to the tops of plastic tubes on a monthly basis or as needed for smaller seedlings can greatly increase the growth rate of host plants.

- Watering- Watering is crucial during dry weather, but can easily be overdone. It is important to check the soil by sticking a finger an inch or so into the soil. If the soil is damp at the bottom of the inch, watering is probably not necessary. Rolling the ends of plastic tubes makes watering easier. Also it is important to be careful of small seedlings when watering as they can be buried or knocked over.

2.2 Quantities Required

- Vines – Vines tend to regenerate and grow much faster than seedlings. A vine of a couple of feet in length with plenty of green growth can support one larva every two months

- Herbs – Herbs like *Justicia* can often be found in great numbers. Transplanting is so easy that it is not necessary to plant large amounts of herbs in advance of farming many larvae. Though herbs tend to recover quickly, it is often easier to simple plant more than to wait for eaten plants to recover.

- Seedlings – The majority of host plants that are needed to farm butterflies in Amani are seedlings of small and large trees. The food requirements can be very large since most seedlings require three months to fully recover from being eaten by larvae. As long as the seedlings has substantial green growth, one seedling of 1.5 – 2 feet is enough to feed one larva of species like *Papilio ophidicephalus*, or two larvae for smaller species like *Papilio echerioides*.

To understand what these numbers mean in terms of the average butterfly-farming group in Amani, it is necessary to make some rough calculations. For instance, in 2004, the average butterfly-farming group can expect to sell about 2250 pupae. This consists of about 1700 pupae for the live exhibit market and about 550 pupae for the dead stock market. The live exhibit market is concentrated in 8 months from the beginning of March until the end of October. The

sales for the dead stock market would be spread out evenly across the year. So, for the live exhibit market, the average group will produce roughly 215 pupae per month for sale and need 645 seedlings every three months to feed this many larvae. The dead stock market adds another 45 pupae per month for the whole year and would increase the host plant requirements by about 135 seedlings every 3 months. So in total, the average group needs about 780 seedlings in their nurseries to meet market demand. However, to make sure that there are sufficient host plants to continue captive populations as well as meet market demand, each group will need to double the number of seedlings in their nurseries. Therefore, each group needs around 1560 plants.

2.3 The Plant Families

2.3.1 Important Flowers for Nectar Feeding Butterflies

- *Lantana camara* – An invasive shrub from India that makes multicolored inflorescences of small tubular flowers. It is easily grown from transplants of almost any size. It occurs all over the Amani area along roads and in open areas.

- *Stechtafeta jamaicaensis* – An invasive shrub from the Caribbean. This plants species seems to offer more flowers and grows better inside shade net cages than *L. camara.* It is also easily grown from transplants of any size. It occurs all over the Amani area along roads and semi-open areas. It is popular with nearly all nectar feeding butterflies.

- *The red tubular flower* – This species seems to be particularly popular with the genus *Papilio*. It is more common at lower elevations but occurs from 800 meters to 300 meters in the Amani area. It grows in both semi-shade and open sunlight.

- *The domesticated tubular flower* – These flowers are very useful for making fake flowers by inserting the bottom of the tube into a tube filled with sugar water. They can be grown easily from seed or transplants.

- *Impatiense* – There are many species of this genus in the Amani area and they are an ideal flower for *Papilio* species. They are very easy to grow from transplants or from seed, but require generous amounts of water. They are mostly found along rivers or other rocky areas with sufficient water and shade.

2.3.2 Important Host Plants

Annonaceae

- *Annona senegalensis* – Probably best from seed but seedlings and rootstocks will grow. Prefers hot weather, open sun and generally grows best below 600 meters.

- *Uvaria* species – Can be grown from seedlings or cuttings. These plants also prefer hot weather and so grow better at lower elevations. Open sun or slight shade.

Rutaceae

- *Citrus* – Lemon, orange, grapefruit, and lime tree seedlings all work for some species of *Papilio*. Lemon is by far the easiest to grow from seed using the seedbed technique. Seedlings of almost any size of any of these varieties can generally be transplanted if cared for well. All *Citrus* grows best in open sun or slight shade.

- *Vepris* – There are at least 3 important species of *Vepris* in the Amani area. At 700 meters and below a single-leafed variety occurs that seems to be the favorite host plant of *Paplio dardanus*. Fruits and very small seedlings of this species can be found in the thousands from April through June below seed bearing trees, most often along the Sigi River. The seedbed method is very effective at germinating these seeds. Two other species of *Vepris* occur at higher elevations, including the very common *Vepris nobilis*. While possible to use seedlings if dug in rainy weather and if the taproot is not severed, most farmers have found it difficult to get transplanted seedlings to grow well. These species of *Vepris* are not as prolific of seeders as the lower species but seeds can be encountered after the long rains. All the *Vepris* species grow best in slight shade.

- *Zanthoxylum* – There are at least 4 types of *Zanthoxylum* in the Amani area. Below 600 meters, a variety occurs that is mostly used by the Fanusi butterfly-farming group. The Fanusi group has had success with cutting of this species and with seedlings, though the cuttings seem susceptible to disease. Fruits have not yet been tried. *Zanthoxylum deremense* occurs most frequently from 800 meters up to 1000 meters. It seems to prefer disturbed areas along the edge of the forest or rivers. It can fruit at just 3 feet. Seedlings are very numerous in some areas and can be transplanted easily at almost any size. It helps to take the green grow off and let it resprout after transplanting. *Zanthoxylum gilleti* is easiest to get from small seedlings, which can be found in the thousands after the long rains in farms, along roads, and in the tea estates where large seed bearing trees are nearby. *Zanthoxylum usambarae* can also be gathered in great numbers in the same fashion as *gilleti*. Seeds from *Zanthoxylum* seem to be mostly infertile so it is difficult to get many seedlings from seeds. All the *Zanthoxylum* species grow best in slight shade.

- *Clausena anisata* – Currently the project only knows one general area to find seedlings and seeds of this species. The location is near the village of Meshewa at around 350 meters in the Longuza forest. It may also occur at higher elevations in other areas. It

seems to be relatively easy to transplant as small seedlings. Seeds have not yet been tried. This species grows well in slight shade.

- *Toddalia asiatica* – This species can be grown from seeds, seedlings, and rootstocks of larger plants. It is a large bush or semi-vine found from 300 meters to 1100 meters in Amani. It grows in open sunlight or slight shade. It does not like too much water.

Sapindaceae

- *Deinbollia* – Two important species occur in Amani. *Deinbollia burbonica* is found at lower elevations and in more open areas such as farms. *Deinbollia kilimanjarica* is found at elevations above 800 meters and is a forest or forest edge species. Both species can be transplanted, but the best method is germinating seeds, which can be found in great numbers in the months of July, August, and September.

- *Allophylus* – Several species of this genus exist in Amani, but it is not yet known which are most useful. No attempt to transplant or grow them from seed has been made.

Melianthaceae

- *Bersama abyssinica* – This species is most common from 800 meters to 1100 meters, but it can be found as low as 400 meters. At the higher elevations, seedlings can be found in great numbers in semi-shaded areas or along forest edges. It has been found that it helps to remove the green growth after transplant to allow the plant to resprout. No attempt to grow it from seed has been made yet.

Lauraceae

- *Cryptocarya liebertiana* – This species grows along ridges and one very large tree can be found on top of Mbomole Hill. Seedlings seem to be difficult to find in great numbers so growing from seeds is probably preferable. No attempt to transplant or grow this species has been made.

Euphorbiaceae

- *Croton megalocarpus* – This species is frequently planted for decoration or shade in the Amani area. Small seedlings can be found under larger trees. It is also easily grown from seed. It occurs from 300 meters to 900 meters in the Amani area.

Caesalpiniaceae

- *Afzelia quanzensis* – This species is found primarily at lower elevations in the Amani areas at 400 meters and below. It can be easily grown from seeds collected from dry seedpods found underneath large trees. Since *Charaxes* species that use this plant are often found at higher elevations in Amani, it can be assumed that other members of this family, such as *Isoberlinia* are likely also used as host plants.

Fabaceae

- *Cassia* – Many species of this genus occur in the Amani area at every elevation along roads and other open areas. Almost all are used as host plants. They can be transplanted or grown from seed easily.

- *Crotolaria* – One species of this genus is very common along roads and rivers in the Amani area. Good-sized seedlings can be grown very rapidly from seed. It is most common from 900 meters to 500 meters.

Mimosaceae

- *Albizia* species – There are a great number of *Albizia* species found in the Amani area. Small seedlings can be found in great numbers in open areas and along the forest edge. No attempt to grow *Albizia* from seeds has been made yet, but presumably they should germinate well. They are found a wide variety of elevations.

- *Newtonia buchananii* – Similarly to *Albizia*, seedlings of this species can be found in great numbers in semi-open areas and along the forest edge. No attempt to grow it from seed has been made.

- *Newtonia paucijuga* – This species has much larger leaves than other *Newtonia.* It is not clear if either species are used by *Charaxes* in the Amani area. No attempt to grow or transplant this species has been made.

Myrtaceae

- *Syzygium guineense* – This is the most common *Syzygium* species and seedlings can be found in open areas. No attempts to transplant or to grow this species from seed have been made. This species is generally found at higher elevations in the Amani area.

Sapotaceae

- *Chrysophyllum* species – Two species of this genus occur in the Amani area. They both are higher elevation species usually found from 800 meters and higher. Seedlings can be very numerous in the forest along paths and even in heavy shade. Seedlings are easy to transplant. No attempt to grow either species from seed has been made.

- *Mimusops kummel* – This species seems to be difficult to transplant, though medium and small sized seedlings are not uncommon from 300 meters to 900 meters. It seems to be particularly common along rivers. Frequently, the taproot is long and difficult to extract. Seeds probably offer a better solution, but no fruits or seeds have been found yet. Another species of *Mimusops* also occurs in the Amani area at lower elevations, but no butterflies have been witnessed using it as a host plant.

Anacardiaceae

- *Sorindeia madagascariensis* – This species is almost certainly a *Charaxes* host plant, but it has not yet been tested. Seedlings are found from 600 meters to 900 meters. No attempt to grow it from seed has been made but it can be transplanted easily.

Meliaceae

- *Trichilia dregeana* – This species is definitely a *Charaxes* host plant since *Charaxes* larvae have been found on it. Small and medium sized seedlings are very common from 800 to 900 meters and may be found lower as well. Another species, *Trichilia emetica*, is likely a host plant as well. It is found more at lower elevations from 600 to 300 meters. At the time of writing this report, the project was transplanting *dregeana*. No attempt to grow either species from seed has been made.

Acanthaceae

- *Justicia* or *Asystasia* species – Unfortunately, the project has not found a good source for specifically identifying host plants in the Acanthaceae family. The main plant used for *Salamis parahassus* is most common along streams from 600 meters to 900 meters. It can completely fill marshy open areas with a thick mat of growth. Transplants generally need two days of shade and water before they are ready to be used.

- *Brillantaisia* – A species of this genus originally obtained from the butterfly-farming project in Kenya has been spread from cuttings among many of the farmers in the project. It is very easy to grow from cuttings as long as one node is above ground when planted.

Asclepiadaceae

- Unknown vine – The project has no good source for identifying members of this family. This unknown vine is simply known in the project as *Amauris* plant and is the host plant for *Amauris niavius.* It can be transplanted very easily or grown from rootstock cuttings. It occurs from 900 meters down to at least 500 meters.

- *Tylophora* species – It is unclear how many species of this genus occur in Amani. Generally, they are vines with small light green opposite leaves that produce latex when broken. They can be easily transplanted or grown from rootstock cuttings. It is frequently found in thickets and grassy areas in Amani at varying elevations.

- *Dregea abyssinica* – This species is easy to transplant or grow from rootstock cuttings. It seems to occur from 900 meters to 300 meters in large openings or along roads.

Urticeae

- *Urera sansibarica* – This species is found growing on large rocks, frequently near water. It occurs from 900 meters to 300 meters in the Amani area. It is easy to grow from

cuttings or rootstocks. It may also be possible to grow from seed but this has not been attempted yet as cuttings are readily available.

- *Urera trinervis* – This species can be found climbing rocks or more frequently trees both along rivers and along the forest edge. It occurs from 900 meters to below 500 meters in the Amani area.

- *Urera* species – Another unidentified species is used by the project. It appears to be a hybrid between the two previously mentioned species. Cuttings and rootstocks work well. It is unclear where it most common.

- *Laportea* species – The species of *Laportea* that is used by the project can be found growing on semi-shaded rocks along streams or roads. It is most common from 700 meters to 300 meters. It can be transplanted. No attempt to grow it from seed has been made, though this may work well.

3) The Equipment

Initially, I believed that is was possible to farm butterflies with very basic and cheap equipment. However, after researching the topic for over a year, I believe that some more complicated equipment is necessary. However, even the more recent improved butterfly farming equipment is a relatively small investment considering the potential earnings.

3.1 Farming Equipment

3.1.1 Cages

- Shade Net Flying Cages (30,000 TSH each) – The Amani Butterfly Project currently uses round shade net cages for flying cages where female butterflies lay eggs on host plants. The cages are 4 meters in diameter and 2 meters high. The circle is constructed by planting 8 or more poles in the ground in the outline of the circle. Typically, the farmers use cut poles from types of trees that will grow from cuttings. The poles are usually about 2.5 meters. In affect, the farmers create extra shade and humidity for their cages. It can take anywhere from 2 weeks to 2 months for the poles to sprout, depending on the weather conditions. Around the outside of the poles, farmers bend thinly cut bamboo to form a frame for the circle.

Then one piece of shade netting is wrapped around the outside of the bamboo. Another piece is sewn to cover the top of the cage. Finally, more bamboo is tied in a between the growing poles inside the cage and pushed up to form a small dome of shade net. The shade netting on the cages is reported to last for 5 years by the manufacture. A finished cage is pictured below.

- Mosquito Net Cages (3000 TSH each, the bulk price for one 6x6 mosquito net) – Originally, I believed that mosquito net cages would be sufficient for flying cages. However, after experimenting with both types of netting, I discovered that most butterfly species fly much better in shade net cages. The problem with mosquito netting is that it is very fine and butterflies seem to bounce of the netting as they fly, where as with shade netting they usually avoid hitting the netting. As a result, the butterflies are much more active in the shade net cages and thus can lay more eggs. Mosquito net cages are useful, however, for rearing larvae. The fine mesh prevents most parasitic wasps from reaching the larvae. Unfortunately, they are not very durable an usually only last one year outdoors.

- Clear Plastic Cages – Some possible alternatives exist for both flying cages and larvae rearing cages. One promising option is to cover the existing shade netting cages with a layer of clear plastic. This would greatly increase humidity and temperature in the cages. It would also in theory make the cages wasp and ant proof if the plastic was buried into the ground. Ventilation would probably be required along the joint between the walls and the ceiling. This could be accomplished with a strip of fine netting or cloth. This method would increase the cost of each cage by about 15,000 TSH. It might also be possible to abandon netting all together on the sides of the cages and just use it on the roof to reduce the amount of sunlight entering the cage. A cage like this would need to be tested in January and February to make sure they are not too hot. For the rest of the year, plastic cages may be ideal for Amani's cool and often rainy weather. Such cages would probably last from 2 to 5 years, depending on the quality of plastic.

- Thin White Cloth Cages – Cloth cages may prove more durable than mosquito net cages and would prevent all unwanted insects from entering larvae rearing cages, while still allowing some light to pass through to the host plants. Cloth is more expensive however and so small rearing cages the size of one 6x6 mosquito net might cost as much as 8000 TSH.

3.1.2 Planting Bags:

- Black Plastic Tubing – The project uses 10 inch black plastic tubing to plant most of its seedlings. The tubes are very durable and should last for several years. They generally require more watering than bags since the bottoms of the tubes are open.

- Plastic Bags – Some groups have substituted regular striped shopping bags for black plastic tubing. The bags are generally a little more expensive and not nearly as durable as the tubing. They do hold more water since the bottoms are closed. It is often necessary to punch a few holes in the bottom to prevent the soil from becoming mud.

3.1.3 Small Plastic Containers
Small plastic containers with lids have proved to be invaluable for protecting butterfly eggs from parasitic wasps and other predators. Many cosmetics and creams come in plastic containers of an appropriate size for storing butterfly eggs. To make a storage container, farmers completely clean the container and then leave it open so that any solvents will evaporate. Finally, holes smaller than one 1mm are punched in the lid of the container.

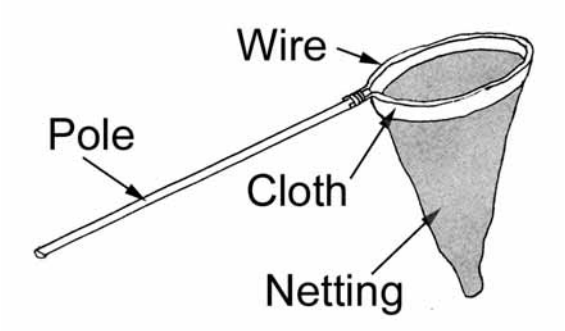
3.1.4 Small Paintbrush
The small paintbrush is the best tool for moving newly emerged larvae.

3.1.5 Net Boxes, Glue and or Pins
Small boxes that consist of either netting or cloth can be used to store pupae. A pupa should be glued to a stick or pinned through the very narrow section of the pupa where the silk pad is located.

3.1.6 Paper Envelopes
Paper envelopes, especially ones made from glassine paper can be very useful for storing dead butterflies. These envelopes are also useful for transporting live butterflies when collecting from the wild. It is a good idea to not keep live butterflies in the envelopes for more than a few hours. Ziploc bags are more appropriate for transporting live *Papilio* species, which tend to become dehydrated in paper envelopes.

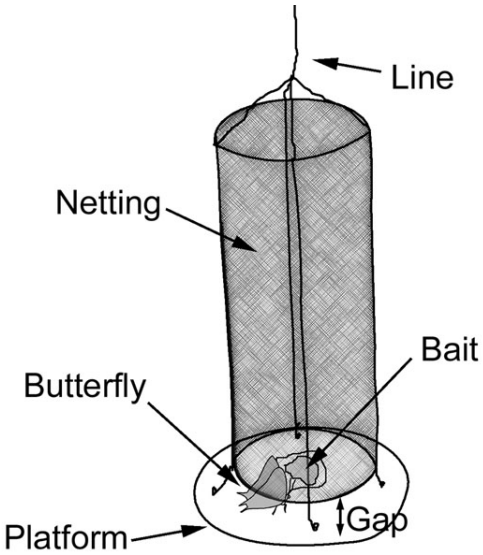
3.1.7 Fake Flowers
Fake flowers are a very effective way of increasing the sugar resources in a small flying cage without filling it entirely with flowers. They can be created using the same small containers that are used for storing butterfly eggs, though the holes in the lid should be about 3 mm in diameter so that tubular flowers can be poked through the holes. The inside of the container is filled with sugar water that is approximately the sweetness of natural flowers, which about one teaspoon of sugar per 200ml of water.

3.1.8 Sweep Nets
Sweep nets are required to catch most species of butterfly in the Amani area. The length of the pole can vary depending on the type of species that the farmer is trying to catch. There are many different designs for sweep nets. Pictured below is a simple but effective design used by the butterfly farmers. The total cost is about 500 TSH per net and they can last several years if holes are repaired regularly.



3.1.9 Hanging Traps

Hanging traps are mostly useful for catching species of *Charaxes* and *Euxanthe.* It is not common to catch any other kinds of valuable butterflies in a hanging trap. The trap should be baited with fermented banana, which is one fruit that is inexpensive and available nearly year round. The bananas should be ripe. Then after being peeled they should be mashed and sealed in a plastic container for at least one week before the bait it used. The basic design of a hanging trap is pictured next.



3.2 Dead Stock and Shipping Equipment

3.2.1 Shipping Boxes

The project plans to use cardboard boxes lined with Styrofoam for shipping pupae. Each pupa will be wrapped in cotton balls and placed into the Styrofoam interior lined with a plastic bag. A 6-liter box lined with 15mm of Styrofoam should hold 150 pupae and a 9-liter box of the same design should hold 250-300 pupae. The same design, excluding the Styrofoam can be used for shipping dead stock.

3.2.2 Syringe and Methyl Alcohol

The project plans to use methyl alcohol to kill butterflies for the dead stock market. Injecting butterflies that have hatched from pupae the same day with .1 to .2 cc of alcohol depending on their size insures A1 quality specimens that are free from damage that might occur with other killing techniques. The alcohol also serves as a drying agent.

3.2.3 Silica Gel

Silica gel is very useful for drying and preserving butterflies for the dead stock trade. An easy technique is to place a small layer of silica gel in the bottom of an airtight container. Then, butterflies in envelopes can be stacked in the box and sealed until they are ready to be sold.

4) The Butterfly Farming Routine

This section describes the butterfly farming system that I have developed over the past year and a half. There are many different techniques for farming butterflies, but I believe that the following routine is the best for the East Usambara Mountains.

4.1 Morning activities

- Collecting seeds and seedlings of host plant species that are needed in the nursery. This task requires a lot of work during the initial few months of preparation for butterfly farming. After a large and healthy nursery is established, this task become unnecessary, except to replace plants that have grown too big every few years.
- Watering – If the weather is dry watering might be needed every other morning. If wet watering may not be necessary.
- Weeding – Conducted if needed.
- Fertilizing – Conducted every month or so.
- Changing Fake Flowers – Butterflies that are nectar feeders often do not like alcohol so it is important to change fake flowers every day so that the sugar water does not ferment.
- Changing Fruit Pieces – Mango is a very good fruit for most butterfly species that enjoy fermenting fruit. However, the fruit pieces should be changed if they are dry or particularly sour.
- Checking the Egg Containers – Containers that are used to gather eggs should be checked every morning for newly hatched larvae. These larvae should then be placed on young leaves of their appropriate food plants in the larvae-rearing cage using a small paintbrush.
- Checking the Pupae Cage – The small net box used to hold either pinned or glued pupae should be checked every morning for newly emerged butterflies. Newly emerged butterflies should be allowed to dry their wings for at least 2 hours before they are handled.
- Hanging New Pupae - The larvae cage should be checked every morning for newly formed pupae. Pupae should be 24 hours old before they are handled to allow sufficient time for their skin to dry. Dry pupae should be glued to a stick or pinned to a board and placed in a net box.
- Catching Female Butterflies – Female butterflies of most species are most visible at flowers and in sunny areas, in the morning between 8 and 11 AM. This is the period of day when they are loading up on nectar or fruit sources before they enter the forest to begin to lay eggs. This task is the most time consuming in the early phases of farming, and is frequently a futile effort. Fortunately, it becomes unnecessary after captive populations are established from 3 to 6 females of each species.

4.2 Mid-day activities

- Catching Male Butterflies – Male butterflies are needed to maintain genetic diversity in the captive populations. For the first generation, which is usually small, it is beneficial to replace all the males in the captive populations with wild caught males. Male butterflies are very active around mid-day, patrolling along the forest edge or on hilltops waiting for female butterflies to pass through their opening.

4.3 Evening activities

- Collecting Eggs – Removing eggs everyday from the fly cages about and hour before dark can greatly decrease the incidence of parasitism in *Papilio* and *Charaxes* eggs. The small wasps that lay their eggs on butterfly eggs are small enough to enter into mosquito netting. Collecting other kinds of eggs can help to protect them from spiders and ants, though wasps are generally not a problem. The eggs should be rolled off the leaves they were laid on and placed in small plastic containers that are ventilated and completely dry. If the weather is not very humid, a small mature lemon leaf should be placed into the container to prevent the eggs from drying. A different container should be used each day for about 10 days to allow for all the eggs in one container to hatch before it is used again. Any eggs that have not hatched after 10 days are probably infected by parasitoid wasps or infertile and should be destroyed.

5) Conclusion

Using the findings of my research for the past year and half, butterfly farmers involved in the Amani Butterfly Project are able to farm over 30 different butterfly and moth species, including many species which have never been farmed before. Still, much work remains to be done. There are still many species of valuable butterfly in the East Usambara Mountains for which the local host plant is not known.

Though the methods and equipment that I have developed are adequate for farming butterflies in the Amani area, it may still be possible to improve upon them. In particular, designing new cages using clear plastic and cloth that are sufficiently ventilated may greatly reduce the incidence of parasitism in butterfly eggs and larvae and eliminate the need to gather eggs from the fly cages. This would save farmers time and increase their yields.

However, knowing how to produce thousands of butterfly pupae is only half the business. The other half is marketing, organizing farmers, management, and negotiating with government agencies. The next section describes my research into the other side of butterfly farming.

Part 2: The Amani Butterfly Project

1) The Amani Butterfly Project

1.1 Introduction

After about 7 months of researching butterfly farming in the East Usambara Mountains between November 2001 and May of 2002, I was convinced that a butterfly farming project in the East Usambara Mountains would be very successful. So, after receiving blessings from forest officials to continue, I presented the idea of starting a project to the Tanzania Forest Conservation Group. TFCG, which already works with several communities in the East Usambara Mountains, accepted the idea of adding butterfly farming to their list of projects.

The project's mission is to provide communities adjacent to forests of conservation priority with a sustainable income that is directly dependent on the presence of healthy forest. It is hoped that such an income will increase community support for conservation in the Amani area. It is also hoped that this project can serve as an example for other parts of Tanzania.

About TFCG

The Tanzania Forest Conservation Group (TFCG) was established and registered in 1985. TFCG aims to promote the conservation of the high biodiversity forests in Tanzania. TFCG is registered under the Society's Ordinance (SO 6275). TFCG currently operates eight participatory forest management projects in the East and West Usambaras, Southern Udzungwas and Coastal Forests. The focus of these projects is on assisting the forest adjacent communities to participate in the management of their forest resources. TFCG also publishes two biannual newsletters "The Arc Journal" and "Jarida la safu ya milima". The Committee governing TFCG is composed of professionals with a commitment to forest conservation.

1.2 Organization

Currently The Amani Butterfly Project is divided into three major components with separate responsibilities and leadership. The goal of the project is to slowly transfer responsibilities and property to the Amani Butterfly Project Group so that the project will eventually be independent of the Tanzania Forest Conservation Group.

1.2.1 The Amani Butterfly Project

Administration

- Project of the Tanzania Forest Conservation Group
- Administered by the project manager and the Tanzania Forest Conservation Group.

Responsibilities

- Buying pupae from butterfly farming groups that are members of the Project Group
- Marketing and shipping pupae on behalf of butterfly farmers to domestic and overseas buyers
- Developing new foreign and domestic markets for farmed butterflies

- Providing technical assistance, training and starting equipment to butterfly farming groups
- Providing starting equipment

Funding

- Startup costs have come from grant-making organizations (See section 1.2 for details)
- Yearly running costs will come from 28% of the market value of butterflies sold by the Amani Butterfly Project Group. This percentage will decrease as sales increase.

1.2.2 The Amani Butterfly Project Group

Administration

- The Executive Committee will consist of three elected representatives from each village involved in butterfly farming (at least one representative from each village must be a woman). The executive committee will elect a chairperson and secretary yearly.

Responsibilities

- Representing butterfly farming groups from each sub-village involved in the project
- Collecting membership fees of 15,000 TSH from sub-village butterfly farming groups
- Holding bimonthly meetings to bring together representatives of the stakeholders (member villages, member farmers, ANR, EUCAMP, the Longuza Forest Reserve, the Muheza District Executive Director's Office, and The Tanzania Forest Conservation Group).
- Purchasing a Trophy Dealers License for farmers involved in the project
- Purchasing Trophy Export Certificates via the Amani Butterfly Project
- Managing a Village Development Fund

Funding

- The Village Development Fund will come from 7% of butterfly sales, which is currently expected to be around 4,400,000 TSH per year.
- A yearly 15,000 TSH membership fee from each butterfly-farming group (totaling 315,000 TSH per year) involved in the project will cover the administrative costs of the Amani Butterfly Project Group, the cost of the Group's Trophy Dealers License, and the cost of Trophy Export Certificates that accompany each shipment.

1.2.3 Sub-village Butterfly Farming Groups

Administration

- Each sub-village group of 10 to 20 farmers will elect a chairperson and have its own bylaws

Responsibilities

- Farming native butterflies using proper farming techniques
- Dividing work evenly amongst members
- Dividing earnings evenly amongst members
- Communicating needs and ideas to the executive committee of the Amani Butterfly Project Group

Funding

- 65% of Butterfly Sales. This percentage will increase as sales increase, since project running costs are mostly fixed regardless of total sales. Currently, it is expected that the average butterfly farmer can expect and extra 135,000 TSH per year from butterfly farming.

1.3 Infrastructure and Startup Funding

The project's current infrastructure consists of the following items.

- A half-acre plot in the village of Shebomeza where electricity and phone are available.
- An office building with an office, workroom, storeroom, toilets, and a 5000-liter water storage tank.
- A 8x12 meter live exhibit
- A tourist/meeting banda
- A 185XL Honda Motorcycle
- A research cage
- A research seedling nursery

The Amani Butterfly Project has received generous support from the District of Muheza, UNDP, the Diplomatic Spouses Group, the African Rainforest Conservancy, and some private donors.

- The project's office was completed with 5,250,000 TSH from the District of Muheza in July of 2003 and an additional meeting room will likely be added with additional support from the district in the near future.

- Butterfly Farming Groups have contributed 15,000 TSH each for the costs of the executive committee representing the farmers, and have contributed over a thousand buckets of sand for building the project office.

- The UNDP has recently approved an award of nearly $24,000 USD that will serve as working capital for the project when it begins purchasing butterfly pupae from the farmers. The organization also approved $5950 USD was approved for technical support and research for the project through the first market season.

- Since September 2002, the Diplomatic Spouses Group of Dar es Salaam has awarded the project 2,600,000 TSH to purchase one motorcycle, build a live exhibit, and purchase shade netting for butterfly farmers.

- The African Rainforest Conservancy located $3160 USD of emergency funding for the project when the UNDP funding was delayed.

- Private donors, including myself have contributed money, time and goods to the Amani Butterfly Project and its farmers.

2) Project Marketing, Shipping, and Payments

2.1 Market Research

2.1.1 Market Demand
To research market demand, a website was created at www.amanibutterflyproject.org. Thus far, 12 buyers have responded and expressed interest in purchasing pupae for the live exhibit season since the creation of this website in June, 2002.

Since most live butterfly exhibits in the Northern Hemisphere close down during the winter months, demand for live butterfly pupae is mostly between the beginning of March and end of October each year. Butterfly exhibits need shipments every 2 to 3 weeks, because the life span of most butterflies in live butterfly exhibits does not exceed this time period. The buyers have indicated that they will purchase 200 to 250 butterflies per shipment. The average price per pupae is likely to be around a $1.75 with a range from $1.00 (for small common species) to $3.00 (for the very large endemic *Hypolimnas antevorta* pictured left). Therefore, if only these 12 interested buyers buy butterflies the project already has the market demand to sell over $60,000 USD worth of butterflies during the live butterfly exhibit season each year. This figure includes an expected 15% loss in shipping, for which the buyers are not expected to pay.

2.1.2 Stability of the International Market
It is expected that market demand will remain relatively constant, as the live butterfly exhibit industry has been growing steadily since the 1970's. Additionally, market demand for African

butterflies is stronger than demand for butterfly species from other areas of the world where butterfly farming is more common.[2]

2.1.3 Seasonality of Market
The project will mediate the effects of seasonality in the market by preparing farmers for periods of low sales, selling dead stock for which there is no season, and by supporting the creation of a domestic display that will provide demand for butterfly pupae during the northern hemisphere's winter.

2.2 Shipping and Payments

2.2.1 Communicating with Buyers
Email is by far the cheapest and most reliable form of communication in Tanzania, and is the method that the Amani Butterfly Project uses to communicate with all of its potential buyers. Once sales begin, buyers will mail an order form available on the Internet to the project staff.

2.2.2 Shipping
The ability to ship to the market quickly is crucial for butterfly farming. If shipments are delayed by more than one or two days, many pupae will hatch in the shipping boxes before they have reached their final destination. Ideally, shipments should reach their final destinations in 5 days or less. The project plans to ship butterfly pupae in Styrofoam lined cardboard boxes via DHL. The DHL head office in Dar es Salaam has indicated that it will be possible for the project to meet their courier bus from Tanga in Muheza. DHL will then meet the bus in Dar es Salaam and put the shipments on a plane the same night.

2.2.3 Payments
The project will use electronic bank transfers to receive payments from overseas. The project's bank account will be in Tanga at a bank capable of international transfers. Once trust is built up between the project and regular buyers, the project's working capital will allow the project to let buyers pay the project every three or four months, rather than after every shipment. This will save buyers money on electronic transfer fees.

Butterfly farming groups will be paid based on the number of pupae they provided each month. At first they will be given 55% of the market price, which should total to 65% of project earnings once 15% shipping losses for which buyers are not charged are factored in. Funds will be transferred into their bank accounts in Muheza on a monthly basis. To access these funds, groups must hold meetings and present the project manager with the minutes of the meeting. To insure this process is followed, the project will hold the bankbooks for each group and the groups' signatories will come to collect their bankbooks with the minutes of their groups meeting.

The 7% development fund will reside in the Amani Butterfly Project Group's bank account in Tanga. The group's executive committee manages this account. Funds will be transferred to this account on a monthly basis and records will be kept to indicate the percentage of the fund that each village is entitled to.

[2] Slone et al. 1997 "A comparison of price, rarity and cost of butterfly specimens: Implications for the insect trade and for habitat conservation" *Ecological Economics* 21: 77-85

3) History of working with Communities

In the July of 2002, a volunteer University of Dar es Salaam student and myself were introduced to the village governments of Kisiwani, Msasa/IBC, Shambangeda, and Kwezitu with a letter from the District Executive Director of Muheza. Then we presented the idea of a butterfly-farming project. These four villages were chosen based on their proximity to good butterfly forest, as indicated by my research, and their relative distance from the Amani Nature Reserve, which was initially concerned about poaching of butterflies from the reserve. While some distance from the Amani Nature Reserve was an important factor in choosing villages, villages that were too far away from the Amani area were also not considered because the project would work best if based in Amani where Internet communication and reliable public transportation are available.

3.1 Village Government Presentation

The presentation to the village governments outlined the following points in this order:

- Although the Division of Forestry and Beekeeping had been convinced of the merits of the potential project, the Division of Wildlife had not yet been consulted and would have to give final approval for the project.
- Butterfly farming exists in many parts of the world and has been very successful in Kenya. A project here would be similar to Kenya except that the villages would control the market like the local dairy cooperative.[3]
- A thorough description about the butterfly lifecycle and how farming would work (with illustrations).
- That the project will work best by incorporating people who lack options for other incomes including women and young people.
- Equipment will be provided and their will likely be a small registration fee to become a member and to be allowed to catch butterflies from the wild.
- Butterfly farming would not effect the environment in a negative way because of the limited number of butterflies required to start very large populations
- When pressed for details on potential earnings, I said that I believed the potential existed for farmers to earn around an extra 100,000 TSH per year for work about 4 days a month. I said pupae prices would be around 600 TSH each.[4]
- If interested, villages should elect three representatives to serve on the advisory committee for the project. At least one representative from each village should be a woman and all the representatives should have at least a standard 7 education.[5]

All four villages agreed to elect 3 representatives for the advisory committee, which was later renamed the executive committee. The first meeting of the executive committee took place on

[3] This statement did not prove to be entirely true. In reality the project is not a cooperative, though may become one after a few years. Currently, leadership of the project is balanced between the Tanzania Forest Conservation Group via Amiri Saidi, the project manager, and an executive committee of three representatives from each village.

[4] It now appears that the average pupae price for the farmers will be closer to 1000 TSH per pupae.

[5] All the villages followed these instructions, except for Kwezitu. There, the village government claimed that there was not sufficient time to hold elections before the first scheduled meeting of the advisory committee and as a result chose representatives from among themselves (since no woman was present at the meeting, the woman representative was chosen without consulting her).

July 21, 2002, which is when work began on the project's constitution and organizing groups of interested farmers.

3.2 History of the Executive Committee

3.2.1 Representation

Originally, each village as a whole elected 3 representatives to the executive committee. However, as the sub-village groups were formed and grew independent of villages themselves, it made sense that the representatives should represent the butterfly farmers directly, rather than the villages. Since there were more than three sub-villages in most of the villages, a system was worked out where representatives would be responsible to report to multiple sub-village butterfly farming groups and not only the sub-village from which they came. Then, after one year of running the project, new representatives were elected in August of 2003. For the new elections, the nominees came from and were elected by the butterfly farmers in each village rather than by the entire village.

3.2.2 Study Tour

In late November of 2002, a study tour was arranged by the Tanzania Forest Conservation Group for members of the executive committee to visit the Kipepeo Butterfly Project in Kenya. Though only a two-day visit, most of the committee members were very impressed by the Kipepeo Project. The committee members appreciated being able to see other people who had already been farming butterflies successfully for 8 years. The visit greatly increased work effort in many groups such as Shambangeda B, though other groups remained unmotivated.

3.2.3 Committee Work

- Attendance – Attendance to committee meetings varied greatly, though usually it was the same people who did not show up for meetings. The distance that the representative had to travel had some effect, but this was not a consistent pattern. Also, committee members that came to meetings regularly were not necessarily harder workers. Several regular attendees came from groups that failed to develop their nurseries past what was originally provided but the project staff. Presumably, these particular representatives came to the meetings primarily for the 1000 TSH sitting allowance.
- Idea Contribution – Each meeting was essentially a discussion between the project's staff and the committee members regarding ways of managing or organizing aspects of the project. Men tended to talk the most and contribute the most number of ideas, though not always very useful ideas in the opinion of the project staff. Women tended to sit together and would only occasionally contribute ideas.
- Productivity – The committee structure, though at times slow, has been productive and has led to the creation of a very thorough constitution. It also oversaw the creation of the project's office, which was completely quickly and within the budget proposed by the District of Muheza. The quality of work in a couple of occasions has been rather poor. Some committee members see the committee as an opportunity to make money rather than as an opportunity to represent their fellow butterfly farmers. Such has been the case when committee members were rewarded contracts to carry out tasks involved the construction of the office. Contracted work, such as making doors and window

frames, has often been of poor quality even though the prices specified by the district were generous.

- Funds management – the committee and the treasure of the committee, with help from the project's assistant field officer have successfully and without incident managed the funds received from the district of Muheza and the yearly membership fee of 15,000 TSH from each butterfly farming group.

3.3 History of the Butterfly Farming Groups

3.3.1 Creating the Butterfly Farming Groups

The responsibility of organizing groups of people interested in butterfly farming was left up to the three representatives from each village. For fairness and to insure that a wide breadth of people were allowed to at least try butterfly farming, it was decided by myself and the committee members that each sub-village would be allowed one butterfly farming group of around 20 farmers. This model was based in part on the Kipepeo Butterfly Project in Kenya, which has organized its farmers into groups of 15 to 20 people. The key difference was that I suggested the committee members would be put in charge of recruiting people to be involved in butterfly farming, where as the Kipepeo project chose people directly based on their proximity to the forest and put farmers into groups with their neighbors. In hindsight, staff members of the Kipepeo project said that this was a mistake because grouping people automatically with their neighbors often put people who did not like each other into the same group and this created conflict in the groups. My only advice to the committee members was that they should look for people who did not have other sources of income, such as women and young people who might want to be involved in butterfly farming.

Initially, the sub-village groups of farmers who were interested in butterfly farming turned out to be quite large. Committee representatives came to the following meetings with lists of 30 to 40 people. However, as work began on collecting host plants and building cages, many group members left until most groups comprised of the current 15 to 20 members.

I explained to the group members that each group should draw a constitution and choose a chairman and secretary. I also encouraged the groups to hold regular meetings and to recognize that once a group was formed, a majority of its members had the power to add or to remove members based on their performance.

Unfortunately, it took some time for the groups to feel independent of the village governments. Some groups were afraid to go against the wishes of their village leaders. This led to confusion in a few cases where village leaders claimed to have the write to expel people from the groups, rather than letting the majority decide. In the village of Kwezitu, the village chairman expelled two people for what appeared to be petty differences. Both people were later reaccepted by a majority of their respective group members.

3.3.2 Training

Butterfly farming training began in July of 2002. Meetings were usually arranged to include all of the sub-village butterfly farming groups from a particular village so that myself and my volunteer helper from the University of Dar es Salaam only had to give each presentation four

times. Usually we asked for 4 or 5 representatives from each group to be present at the training sessions.

Initial training focused on identifying of host plant identification, gathering seedlings, making cuttings and constructing butterfly-farming equipment. After the basics of butterfly farming had been described and the farmers had been taught to identify the most important host plants, project staff began to make regular visits to each group to give more specific advice.

From October 15, 2003 until February 2003, the responsibility of training was given to project's field assistant and the project's assistant field officer, while I returned to the US. They continued to focus mostly on host plants and host plant care. Then in January of 2003, they began to include training on butterfly capture and identification. Groups were provided with black and white copies of a basic identification guide that I assembled. Each village was give two color copies as well to share amongst all the groups in their village.

In late February, training began to focus on establishing captive populations of desirable species and the correct handling of different butterfly life stages. This training has continued to date as the farming groups, the project staff, or myself discover improved farming techniques. Also, training continues to add new butterfly species to the list of farmable species and therefore farms are continuing to plant new host plants species.

3.3.3 Effectiveness of Training

Butterfly farming is a new technology to Tanzania and in many ways, keeping butterflies is much more demanding than keeping domesticated animals. Butterflies are far less capital intensive than most animals, but they demand consistent attention. Likewise, the seedling nurseries also need consistent care such as watering, weeding and fertilizing. I suspect that this is very different from most crops that are grown in the Amani area, which are essentially left after being planted and occasionally weeded. This need for consistent care, poor group leadership, and the lack of immediate monetary rewards has made butterfly farming a difficult technology for many farmers to adopt.

For example, I discovered that *Papilio* eggs were especially susceptible to parasitic wasps that lay their eggs on fresh *Papilio* eggs. To get around this problem, I have started collecting *Papilio* eggs from the study cage every afternoon. This task takes about 15 to 20 minutes depending on the number of host plants to check, regardless of the number of eggs. Farming groups were first told about the importance of doing this in April of 2003 and have finally adopted this technique in September or 2003.

The lack of immediate monetary rewards is one factor that is not necessarily a given with butterfly farming and the fact that the farmers have gone for such a long time without monetary rewards has greatly reduced farmers motivation and attention to new butterfly farming techniques. The government sections details the cause of this problem.

3.3.4 Butterfly Farming Group Work

Originally, it was expected that butterfly farming group members would all do equal amounts of work each month according to a set schedule. The daily work required 2 group members per day,

so that groups consisting of 15 members would expect group members to contribute roughly 4 days of work per month. This would also mean that once the project began selling, group members would receive equal pay. However, after nearly a year it became obvious that this system was untenable because it discouraged the most motivated farmers from doing extra work. To fix this problem, it was proposed that the secretary of each group should keep track of group member's work on a daily basis. This proposal was met with applause from nearly all of the groups.

Though all groups began with the same equal work system, the progress and work effort among different groups has varied widely. Progress is defined as the size and quality of a group's seedling nursery, the quality of their equipment, and the number of species that the group is able to farm. Some observations offered clues to the factors that affect group progress.

- Women – Butterfly farming groups that consisted of at least 50% women tended to progress faster than groups that were dominated by men. The sub-village groups of Kagera and Shambangeda B were good examples of this phenomenon. Although, most of the group chairmen are men, women seem to add a consistent work force that can water, fertilize and weed on a regular basis.

- Young Men – Butterfly farming groups that consisted of mostly young men such as the sub-village groups of Makanya and Mlola, were inconsistently motivated. This resulted in having to start over several times after host plants had been neglected for at least a couple of weeks. These two groups in particular seemed to find it very difficult to work consistently for a monetary reward that was not immediate.

- Leadership – The primary factor affecting group development was good leadership. Highly motivated chairmen who would often do more than their share of the work had a positive effect on motivating other group members to work consistently. Chairmen that viewed their position as indicating that they were not required to work severely stunted the progress of their groups. This particular problem was most pronounced in the sub-village groups of Gonga and Mkaramu, where village chairmen who were executive committee members also held the position of butterfly farming group chairman.

- Fairness – Perceived fairness in the distribution of work was much more important to most of the farmers than whether their group progressed at all. Groups that could organize a fair work schedule and stick to the schedule continued to improve. Hopefully, the new system of keeping track of work and paying workers based on the percentage of their group's work that they do each month, will provide a fairer system and motivate more farmers to work.

4) History of Working with the Government

As a new project involving a mixture of conservation and development issues, the creation of Amani Butterfly Project required significant government input. Initial skepticism was common in all the different government agencies consulted during the development of the project. However, after reviewing the project's proposals, most government agencies have strongly supported the creation of the project. This section describes the specific interactions that the

project has had with each government body. The government authorities are listed in chronological order according to when they became involved in the project.

4.1 The Division of Forestry and Beekeeping

My initial research for the project was carried out in the Amani Nature Reserve and neighboring forest reserves. The director of Forestry and Beekeeping approved this research after I was awarded a COSTECH research permit. Originally, I intended to only conduct a feasibility study as proposed in my US Fulbright funded research proposal. However, after 7 months of research from November of 2001 to May of 2002, it became apparent that a butterfly farm in the Amani area would likely be very successful, so I started inquire about the possibility of starting a project.

At first, the local forest officials were concerned about the impact that such a project might have on the Amani Nature Reserve, which is suppose to be a none extraction zone. They proposed that the Nilo Forest Reserve would be a better location, since it did not have the same restrictions as the Nature Reserve. Unfortunately, the Nilo Forest Reserve is quite remote and would not meet the criteria of having reliable communication and transportation.

As a compromise, local forest officials from the Amani Nature Reserve and the East Usambara Conservation Area Management Program agreed that as long as butterflies were not captured in the Nature Reserve, the project could be started in other forest reserves and community forests near Amani. Eventually, we settled on the villages of Kisiwani, Msasa/IBC, Shambangeda, and Kwezitu.

This compromise was submitted to Director of Forestry and Beekeeping, who indicated that he agreed with the proposal.

4.2 The District of Muheza

Next, I submitted a proposal to the District Executive Director of Muheza. After some revisions to the proposal, he was very supportive of the idea of butterfly farming and arranged a stakeholder meeting involving the relevant district officers and the local forest authorities from the Amani Nature Reserve, the Longuza Forest Reserve, and the East Usamabara Mountains Conservation Area Management Program.

The results of the meetings were very positive, with each stakeholder agreeing that the project should go forward. The District Executive Director agreed to write a letter of introduction to the four villages that would initially be invited to start the project.

Strong support has continued from the district, culminating with the award of 5,250,000 TSH from Irish Aid via the District of Muheza for the purpose of building the project's office in the spring of 2003. The project has also received technical advice regarding the Amani Butterfly Project Group's constitution.

4.3 The Village Governments

The government authorities of villages involved in the project have all been very supportive. The village chairmen proved integral in helping the project to arrange meetings and notify attendees

during the first few months of the project. For instance, a single letter could be sent to the village chairmen of Msasa/IBC and all the required sub-villages from not only Msasa/IBC, but also Shambangeda would show up at the appropriate location. This organization and cooperation between villages was very helpful.

4.4 The Division of Wildlife

On October 1st 2002, the Tanzania Forest Conservation Group submitted a proposal on behalf of the four villages involved in the Amani Butterfly Project to the Director of Wildlife. Since the Division of Wildlife is responsible for all wildlife in Tanzania, it must approve any economical use of wild animals. Although many other types of animals in Tanzania are legally farmed for export, no company or individuals have legally farmed butterflies.[6] The Amani Butterfly Project is the first project of its kind.

The Director of Wildlife assigned the responsibility of investigating the project to the CITES officer who is in charge of considering CITES permits and ranching permits.[7] Conveniently, this officer was able to attend a study tour arranged by the Tanzania Forest Conservation Group to visit the Kipepeo Butterfly Project in Kenya along with the butterfly farmers executive committee.

Since the class 17 Trophy Dealer License for ranching/farming a wide variety of animals already existed, I assumed that the permitting process would be completed in time for the project to have an answer in the spring of 2003, which was when I expected the farmers to be ready to begin selling. However, despite repeated verbal promises, the CITES officer was not able come to inspect the project until late July 2003, even though the farmers had been ready to begin farming for export since the beginning of May of 2003. It is clear that the CITES officer has many responsibilities, but it also seems clear that visiting the Amani Butterfly Project was ranked as a low priority.

After his inspection, the final report was prepared by the CITES officer and submitted promptly to the Director or Wildlife in early August of 2003. In early September, TFCG learned from the assistant director that the proposal was passed with an endorsement from the Director of Wildlife to higher authorities, which TFCG has assumed to be the Ministry of Tourism and Natural Resources. All further inquires by TFCG have been met with the same response.

On September 20, 2003 members of the executive committee of the Amani Butterfly Project Group sent a letter to the Director of Wildlife. The letter requested an update on the status of the proposal and explained that many farmers were losing hope after waiting for such a long time for permission to begin selling.

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[6] At least one individual in the Moshi area farmed 4 *Papilio* species and exported pupae for a few years in the late 1990's and possibly even in the year 2002. Evidence for this has come from a former employee of this individual who recently came looking for work at the Amani Butterfly Project. There is no evidence that his operation was legally permitted from the Division of Wildlife, since they insists that our project is the first to farm butterflies. The website of the London Pupae Supply lists Tanzania as one of their sources of pupae and the former employee confirmed that the London Pupae Supply was one of their buyers.

[7] No butterflies from the continent of Africa are listed under CITES.

Then, on October 10th, 2003 a year and ten days after submitting the proposal to Wildlife Division, we received a text message confirming that the project had been approved by the Ministry of Tourism and Natural Resources and that the Wildlife Division was preparing our Trophy Dealers License.

The experience of working with the Division of Wildlife has been very frustrating for the project staff and butterfly farmers. Many butterfly farmers had let their butterflies go and are only giving their host plants basic care to keep them alive, when notice of the permit arrived. It was very difficult for farmers in the Amani area to continue to work when there was no financial reward. Some people looking at the situation, including people from inside the Division of Wildlife, have questioned the wisdom of starting the project before it had been approved. The problem with this argument is that an inspection by a wildlife officer is required before a Trophy Dealers License can be awarded and if the project had not been started, there would have been nothing for the CITES officer to inspect this past July. Also, butterfly farming requires a good deal of start up time and it would be impractical to wait a year for a permit and then spend another eight months getting ready to farm after receiving the permit.

5) Conclusion

The Amani Butterfly Project has already been very successful in many ways and has created a new and interesting model by which government agencies, NGO's and local communities can work together. The system by which TFCG can transfer skills and responsibility to the Amani Butterfly Project Group is a unique way of directly involving communities in their own development. The project is also one of the few examples of a project that can seamlessly combine conservation with a substantial and sustainable source of income for local communities. I am confident that the project will be very successful once the farmers are allowed to begin selling butterflies and in future years I believe it will be adding over $100,000 USD to the Tanzanian economy every year.

It was unfortunate that the project was delayed for such a long time, and that many farmers involved became very frustrated. The experience clearly shows how government agencies can either help or hinder development. It was very surprising that a project, which received strong support from many government agencies and the news media, would be ranked as such a low priority by one government agency that its potential was threatened.

Now that the project has been awarded its Trophy Dealers License, the success of the project lies once again with the project's staff and farmers. The market is ready so sales should begin as soon as the farmers raise production back up to marketable levels.