JICA Partnership Program
(Partner Type)

"Education and training of Myanmar personnel for the realization of phyto-diversity conservation and sustainable use of plant resources to improve economy of the rural population"

Project Report

December 2013

The Kochi Prefectural Makino Memorial Foundation, Inc.
Japan International Cooperation Agency, Shikoku Branch Office

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Project Report

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Project Overview

1. Background and Necessity of Project

Though the plant resources (economically important plants) in the Republic of the Union of Myanmar still remain rich, their sustainability is endangered by the accelerating disturbance such as unlawful collecting, shifting cultivation etc. Unless countermeasures are taken so as to realize the conservation and sustainable use of such plant resources, the people of Myanmar, especially villagers and those of rural communities whose life largely depends on plant resources, will soon face serious problems in their economy.

This unfortunate situation is caused mainly by a lack of qualified specialists and leaders, causing the delay of economic botanical inventory and education of people in local community in relation. The urgent need, therefore, is to ameliorate this situation, for which training of related specialists, especially systematic/economic botanists, park rangers and extension officers is necessary to wake up and move the people of rural communities toward the appropriate managements of forests and other natural areas.

With the objective of protecting plant resources and establishing its sustainable use, the Forest Department (FD), the Ministry of Environmental Conservation and Forestry of the Republic of the Union of Myanmar and the Kochi Prefectural Makino Memorial Foundation Inc. (MBK) of Japan jointly started a project supported by Japan International Cooperation Agency (JICA) Partnership Program. “Education and training of Myanmar personnel for the realization of phyto-diversity conservation and sustainable use of plant resources to improve economy of the rural population” was initiated in the Natma Taung National Park in Chin State for two years and ten months starting in September 2006.

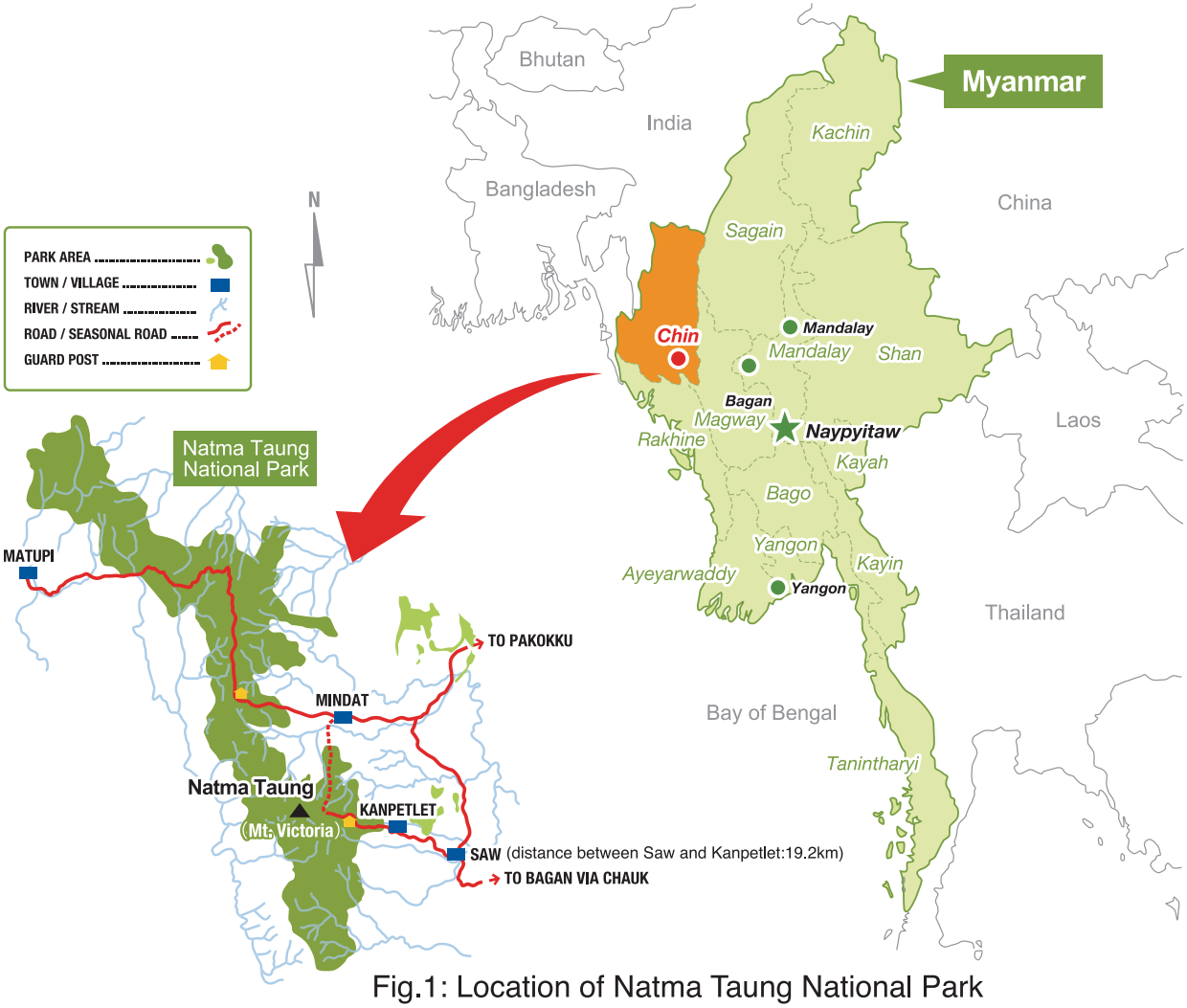

Fig.1: Location of Natma Taung National Park in Chin State, Myanmar

2. Project Details

Achievement Goals as a JICA Partnership Program

The major objectives of this JICA project are to train personnel to do inventory of economic plants and their conservation and sustainable use as well as to educate the local community members of Natma Taung National Park. To achieve these goals, field inventory in Myanmar will be carried out by the joint Myanmar-Japan team and subsequent research in Makino Memorial Foundation Inc., including an invitation for a field research officer from Myanmar to train in Japan.
In consideration of these points, the following objectives were set:

1) The skill development and training of the rangers in Natma Taung National Park in order for them to raise the local villagers' awareness for plant resource conservation and sustainable use.
2) Identify the species of medicinal orchids and other economic plants being illegally collected from the natural forests, attempt to cultivate these to conserve as well as to get the income for the villagers.
3) Introduce annual plants and buy the harvest to immediately secure cash income for the villagers.

Project Outlines

1) Country: The Republic of the Union of Myanmar
2) Title of the Project: Education and training of Myanmar personnel for the realization of phyto-diversity conservation and sustainable use of plant resources to improve economy of the rural population.
3) Target Area: Chin State (Natma Taung National Park).
4) Target Group: The main target group consists of the low-income villagers in the areas under the jurisdiction of local administration officers of Forest Department, the Ministry of Environmental Conservation and Forestry.
5) Expected Outcomes:
   A. Education and training of technical staff members of Forest Department in the fields of systematic/economic botany, forest ecology and environmental assessment with the final aim to complete the database of plant resources of Myanmar.
   B. Guidance of orchid cultivation (*Dendrobium*) and discouragement of shifting cultivation in the target areas.
   C. Identification and introduction of high value-added economic plants as the cash crops and other feasible uses. This will create job opportunities and stabilization of cash income of rural people.
6) Project Term: from September 2006 to June 2009
7) Implementing Organization: The Kochi Prefectural Makino Memorial Foundation, Inc. (MBK) and the Forest Department, Ministry of Environmental Conservation and Forestry (FD).
8) Main Activities of Makino Memorial Foundation, Inc. (MBK): Research and development of industrial resource plants; research and education in the field of systematic/economic botany and plant ecology; also cultural activities to honor Dr. Tomitaro Makino, respected as the “Father of Japanese Botany”.
9) Past Activities and Achievements in the Target Country of Makino Memorial Foundation, Inc.:
   A. Research and analysis of the diversity in industrial research plants from 2001 to March, 2005; research in industrial resource plants in Mandalay and Natma Taung (Mt. Victoria); education and training on the methods of collecting samples and making an inventory of industrial resource plants.
   B. Investigation and research in botany and pharmacy of industrial resource plants from 2000 to the present; currently identifying and analyzing the components of the 7,000 sample plants collected by the joint Myanmar-Japan research team with some of the samples showing hopeful outcomes; searching for potential medical herbs and plants on Myanmar; introducing the cultivation of apples to discourage shifting cultivation in the southern part of Chin State.

Chapter II

The Nature and Culture of Natma Taung National Park

1. Outline of vegetation

Kazumi Fujikawa

Natma Taung (Mt. Victoria) in southern Chin State, the highest mountain in this area of the Republic of the Union of Myanmar (hereafter "Myanmar"), forms the heart of the Natma Taung National Park with its lofty peak of 3,053 m altitude. The National Park encompasses 722.6 square kilometers of rugged and verdant mountainous terrain. The region's arcing slopes mostly range between 1,500 m and 2,000 m altitude and unfold into the vast Ayeyarwady plains to the east. Natma Taung and its surrounding areas have long been renowned for their extraordinarily rich diversity of flora and fauna. Natma Taung was inscribed as a national park in 1994 to safeguard its superlative assemblage of plant and animal life.

The Chin Hills form part of the Rakhine-Yoma Range, a folded mountain belt uplifted in the Miocene Epoch that skirts the Bay of Bengal and bears northwards along Myanmar's western border. From here the peaks rise steadily in elevation until they meet the Himalayas in Manipur, northeast India.

The diverse vegetation of Natma Taung is the result of the combined effects of geologic history, geography, elevation and the Man. Kanpetlet with a population of about 3,000 is the gateway to the Natma Taung National Park situated at ca. 1,200 m altitude on a ridge leading to the summit of Natma Taung. The surrounding area of this town is largely used to support the local population, and little natural vegetation remains around villages. In this area, secondary forests consist of pine, alder, and other fast growing tree species with wind-dispersed seeds or re-sprouting root suckers. Himalayan cherry, *Prunus cerasoides* D. Don and *Docynia indica* (Wall.) Decne. (Rosaceae), and *Schima wallichii* (DC) Korth. (Theaceae) grow on roadsides. The roadside is commonly covered with the naturalized undergrowth of an invasive cosmopolitan weed, *Ageratina adenophola* (Spreng.) R. King & H. Robinson (Asteraceae). Most villagers have home gardens where they cultivate vegetables, fruits like jackfruit and banana, in addition to cash crops such as avocado, coffee, tea, and caster oil plant.

Below 1,000 m, the forest is mainly composed of *Dipterocarpus tuberculatus* Roxb. (Dipterocarpaceae), *Buchanania lanzan* Spreng. (Anacardiaceae) and several species that grow in this zone are used for tools, houses, and other utensils. We can find patches of the natural forest composed of *Lithocarpus lindleyanus* (Wall. ex A. DC.) A. Camus, *Saurauia nepalensis* DC. (Actinidiaceae), *Grewia eriocarpa* Juss. (Tiliaceae), *Gmelina arborea* Roxb. and *Syzygium albiflorum* (Duthie ex Kurz) Bahadur & R. C. Gaur (Myrtaceae) beside a stream.

The natural vegetation of Natma Taung comprises temperate forests that extend up to ca. 2,900 m above sea level from ca. 2,000 m. On south-facing slopes and along ridges, the distribution of certain species is clearly delimited by elevation. *Pinus kesiya* Royle ex Gord. (Pinaceae) is the dominant species and *Alnus nepalensis* D. Don (Betulaceae) and *Lyonia ovalifolia* (Wall.) Drude (Ericaceae) occur together at around 2,300 m altitude. On the forest floor and extending up to the meadow, *Viola biflora* L. (Violaceae), and *Curcuma* spp. (Zingiberaceae) are flowering. In the mixed *Pinus kesiya* forest, rich in many ephiphytic species including *Coelogyne nitida* (Wall. ex D. Don) Lindl. (Orchidaceae) and *Agapetes mannii* Hemsl. (Ericaceae), and *Quercus semecarpifolia* Sm. (Fagaceae) and *Rhododendron arboreum* Sm. (Ericaceae) occur at altitudes up to the meadow zone starting at around 2,700 m altitude.

Species-rich temperate oak and/or laurel forests are also abundant around Natma Taung, except on dry or south-facing slopes and ridges described above. The forest is composed of tall and dense evergreen trees with a rather closed and continuous canopy. *Lithocarpus* and *Quercus* species, as well as members of the Lauraceae, are dominant. In addition, *Cornus oblonga* Wall. and *C. capitata* Wall (Cornaceae), and *Myrica esculenda* Buch.-Ham. (Myrtaceae) are seen along the roadside at ca. 2,300 m altitude. This forest also has a rich understorey. Seven species of Araceae belonging to the genera *Arisaema* and *Typhonium*, and more than ten species of Liliaceae s.l. belonging to *Polygonatum*, *Disporum*, *Ophiopogon*, *Asparagus*, *Allium* and *Aletris* are found. Along the foot trail at elevations around 2,600 m, dominant trees are *Lithocarpus*, *Quercus*, and *Castanopsis* (Fagaceae) species and *Symplocos* spp. (Symplocaceae). Shrubs include such species as *Vibrunum cylindricum* Buch.-Ham. ex D. Don (Caprifoliaceae), *Berberis wallichiana* DC. and *Mahonia napaulensis* DC. (Berberidaceae).

High montane meadows dominate above the forest line to the peak of the mountain (3,053 m altitude). They are characterized by the species endemic to this area such as *Potentilla montisvictoriae* H. Ikeda & H. Ohba (Rosaceae) and *Roscoea australis* Cowley (Zingiberaceae), and also growing Sino-Himalayan

element's species such as *Anemore obtusiloba* D. Don (Ranunculaceae), *Primula denticulata* Sm. (Primulaceae) and *Gentiana sino-ornata* Balf. f. (Gentianaceae).
(quoted from 'A Guide to the Forests of Natma Taung' and Newsletter of Himalayan Botany No. 41)

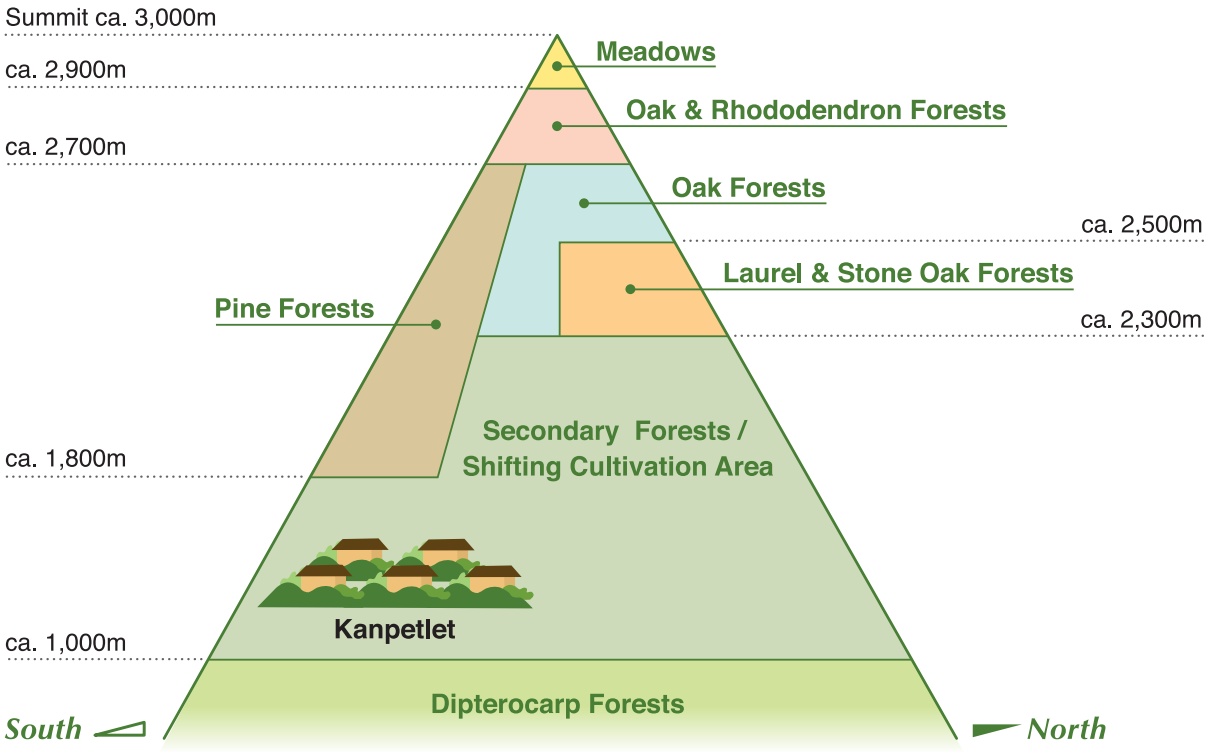

Diagram of vegetation types in the Natma Taung National Park

References

Fujikawa K., N. Kuroiwa, A. Maeda, P. Srisanga & Shein Gay Ngai. 2007. Botanical Expedition to Natma Taung (Mt. Victoria) National Park, Chin State, west-central Myanmar in 2007. Newsletter of Himalayan Botany, no. 41: 8-13.

Fujikawa K., N. Kuroiwa, A. Maeda, G. Gale, Shein Gay Ngai & Aung Din. 2008. A Guide to the Forests of Natma Taung. 30 pp. Kochi Prefectural Makino Botanical Garden, Japan & Forest Department, Ministry of Forestry, Myanmar.

2. Living Conditions

Shigeo Yasuda, Project Manager

Chin State, which lies on the western edge of Myanmar, is still a restricted area. Foreign tourists who want to visit, even for a few days, need to apply for advance authorization from the administrative government department. Even with the authorization, one would need to drive on a bad road for around 8 hours from the nearest tourist area of Bagan. An American woman visiting the area described the trip as a "bone shaking drive" and this is quite well-put. As such, visiting the area is not at all easy. We were told that it was the first time a foreigner lived in the area with such bad access after the World War which ended 1945.

I would like to categorically record the living experiences during my two years in the project site as the resident manager, which only became possible after special reference from the Ministry of Environmental Conservation and Forestry.

1) Housing Conditions

Fig. 1. A house of the staff of Forest Department. Tin roof and outdoor toilet shack. Water for washing up is simply left to drain.

All of Chin State lies in mountainous regions. Towns that are central to the southern region of the State like Kanpetlet and Mindat have developed alongside the mountain ridges. As such, the right and left flanks of the towns are sudden steep slopes. Flatlands are very rare and homes are constructed on stilts on slopes. The stilts are probably meant to adapt to slopes and also help release humidity for more comfortable living during the long rainy season.

The floor and walls are made of single pine wood planks. Roofs are thatched but more increasingly tin roofs are replacing them. Inside, a part of the space behind the hearth is setup as a kitchen and water is used outside on a balcony-like space. There is no drain and everything is simply drained off the side of the hills. Although this method may have been effctive up to now, with the increasing amounts of plastic products, the scenery is being tarnished.

Fig. 2. A residence in Old Town village. It is a traditional construction to this area. Wild orchids are strapped to the poles outside.

Fig. 3. Walls are single pinewood planks. The simple interior is covered up with posters of actors from Korea and Myanmar.

Fig. 4. Interior of the home in Fig. 2. The exit to get down to the ground is inside the home. It was explained that it was a secret exit in case of enemy attack. Currently, there is no such tribal warfare.

2) Fuel Conditions

Firewood and charcoal both serve as fuel. There is greater use of charcoal in the townships and surrounding villages rely solely on firewood. Charcoal costs about 1,000 Kyats per bag (about 15 kg) and firewood about 500 Kyats per one basket. A family using firewood for cooking would consume about 2 tons of firewood per year. There is a need for thorough recognition that one of the benefits of hydropower deployment in the area is to preserve the forests. Fuel for motorcycles (gasoline) and trucks (diesel) are purchased at Saw at the foot of the mountain.

Fig. 5. One important cash source for surrounding villages is the sale of firewood. Selling one bundle in Kanpetlet would bring in 500 Kyats (about 50 cents).

Fig. 6. Ditto. A spray of *Rhododendron* that has started to bloom is placed on top as an ornament. December 27, 2007.

Fig. 7. On the way back from Saw, picking up dead wood alongside the road for use as firewood.

Fig. 8. Ma Kyaw is boiling water using firewood.

Fig. 9. Pinewood pieces being sold at a store in Kanpetlet for starting fires. These are cracked pinewood trunks rich in resin and used to set charcoal on fire. It is cheap in Kanpetlet (one in the photo is typically 100 Kyats), but valuable in lower tropical areas.

Fig. 10. Cooking with charcoal. However, poorer villagers do not use charcoal and mostly use firewood.

Fig. 11. On the way back from Saw, purchasing charcoal from a charcoal producing family. A bag is sold at 1,000 Kyats (approx. 1 USD).

Fig. 12. A drum of gasoline bought in the town of Saw at the foot of the mountain and brought back to the village. About two bottles of mineral water worth is used as fuel for motorcycles.

Fig. 13. A woman who walked 7 hours to Kanpetlet to sell honey. In her hand is a bee's combs found on a tree branch. Honey in a four litres bottle was 8,000 Kyats (8 USD).

Fig. 14. Mushrooms that were being sold in Kanpetlet. June 4, 2008.

Fig. 15. Very tasty figs (*Ficus semicordata*) can be obtained in lower altitude areas within Kanpetlet. July 11, 2008.

Fig. 16. A village woman came to sell fresh kidney beans. One bunch is 100 Kyats. June 12, 2008.

3) Food Conditions

The staple food at Kanpetlet Township is rice. However, it is impossible to cultivate locally so all of it is bought from the Magway region at the foot of the mountain. The staple crop of surrounding villages is corn produced through shifting (slash-and-burn) cultivation. However, because the harvest is not enough to meet annual demand, the deficit is met by buying rice from Kanpetlet. As such, villagers need cash to buy rice for daily consumption.

Vegetables are by default mostly cultivated by oneself, regardless of township or village. It is hardest for villagers to consume protein. The eggs of free-range chicken at home are probably the easiest protein source. Next, this is followed by chicken, pork, and Mythun beef. We heard that poor villagers eat meat about once a month on average. As such, any wild protein sources like field rodents, frogs, snakes, and jackrabbits are eaten.

Fig. 17. The vegetable market in Kanpetlet. Garlics, tomatoes, onions, eggplants, hot peppers, Chinese cabbages, cabbages, and water spinach have been carried from the foot of the mountain. November 12, 2008.

Fig. 18. The vegetable market in Kanpetlet. Winged beans. November 13, 2008.

Fig. 21. The fermented local brew is transferred to a pot and served after adding water. May 6, 2007.

Fig. 19. Freshwater fish and shrimp from the Saw river. The sales price in Saw is 300 Kyats and 500 Kyats in Kanpetlet. Sometimes the shrimps are still alive, as it is transported by motorcycle.

Fig. 20. Large fish from the Mone river in the west of the National Park, about one day on foot from Kanpetlet, is brought in after being smoked. It is a luxury that costs about 2,000 Kyats per head.

Fig. 22. Locally known as Chin beer, it is made by fermenting millet in a container of hollowed out lumber. Hilong village. August 15, 2007.

Fig. 23. Dried frogs brought from Saw. March 5, 2008.

Fig. 24. A captured jackrabbit. This is a feast. Plenty of jackrabbits can be found around the township. Rabbits may look cute, but to the farmer they are no more than vermin.

Fig. 25. Negotiating the price for a chicken to be served to guests at the hotel. This chicken was 5,200 Kyats. Old Town village.

Fig. 26. Chicken being sold at the market in Mindat.

Fig. 27. At the market in Mindat. A Mythun brought for its beef. As it is quite big, one is thought to cost about 300,000 Kyats.

Fig. 28. Likewise at the Mindat market. Mythun beef is being cut up. Shoppers in the forefront. Its head is lying in the center back.

Fig. 29. On the streets of Oak Pho. A dog is being cooked. It is sometimes a valuable protein source for poor villagers.

Fig. 30. A pig was slaughtered for a celebratory feast. As the tripe is immediately cooked, boiling water is already prepared.

4) Electricity Conditions

Electricity in Kanpetlet is below rudimentary. There is a publicly operated generator, but it is financially difficult to purchase diesel. Even town centers receive only two hours worth of electricity between 7 and 9 in the evening, but only once a week. It is mostly used for lighting, DVD viewing, and karaoke. The few DVD viewing rooms in town use charged batteries and screen Korean dramas (ticket for one is 100 Kyats).

As the area is mountainous with a long rainy season, there are streams that do not dry up even during the dry season. The benefits that a mini hydropower installation

Fig. 31. Purchasing gasoline at Saw, the town at the foot of the mountain. One drum of gasoline contains 50 gallon (about 200 liters) and costs 4,000 Kyats per one gallon.

in this stream may bring to this area are incalculable. Even if electricity was provided only for three hours per day, it is thought that the following benefits may be realized. 1) Students can find time to study at night; 2) Reduced use of firewood by using electricity and therefore protect the forest (as mentioned before, annual consumption of firewood per family is up to 2 tons); 3) Supply to the hospital would allow preserving vaccines and operating x-rays and other medical equipment; and 4) (Perhaps the most important of all) People would be freed from the dark for a certain period of the night for DVD viewing, reading, and other leisurely activities and can help to a decline of the excessive rate of population growth (birth rate).

Fig. 32. Gasoline is transferred from the drum to a plastic tank and used to fuel a generator (YAMAHA, bought in Yangon). A little sucking and spitting to get the pump going and the process is finished.

Fig. 33. This generator will provide about two hours of electricity at night. It often broke down because of sand and water contamination of the gasoline.

Fig. 34. The diesel generator at the power plant in Kanpetlet. Because the diesel is extremely limited, electric supply to the town is very limited (once a week, about two hours per one night).

Fig. 35. Homes that have batteries bring their battery to the generator house and charge them up. It takes an entire day to charge and costs about 1,000 Kyats.

Fig. 36. The distribution line to four zones in the town.

5) Communication Conditions

The poor communication is not limited to Natma Taung and is a nation-wide issue, but the problem is especially bad in this area. In the first year of the project, a public telephone facility with a satellite telephone installation was used to communicate with Yangon (overseas phone calls are not permitted from this telephone facility). In 2009, CDMA satellite phone service was introduced to spread and domestic phone call conditions have dramatically improved.

Internet could be used by using the lines of this satellite communication network. The internet available through the satellite communication network at the project office was of course the only one in the village.

Fig. 37. The telephone facility in Kanpetlet that uses satellites. The antenna can be seen in the background on the right. It could only be used when the diesel generator was operating. It could be used every day, two hours each in the morning, afternoon, and evening.

Fig. 38. A solar panel is also being used for back-up power

Fig. 39. The view inside the facility. In the forefront is the satellite phone and in the background a radio device for communicating with Mindat.

Fig. 40. Within Kanpetlet, this hand crank operated phone can be used for communication.

Fig. 41. CDMA phone has started to rapidly proliferate from the beginning of 2009. As of May 2009, 5 phone shops were setup within the township. It was operating throughout the day. The former public telephone facility (Fig. 39) could no longer compete and was open but with little business.

6) Educational Conditions

Primary and middle school education are mandatory, so even the poorest villages sent their children to school with almost no exception. Perhaps because of the local culture, there were no questions asked to the lecturer and students would chant in unison. It seemed that the level of instruction was not particularly high.

If the children progress to eleventh grade, they are given the right to move on to college. The examination to advance to eleventh grade is held nationwide on the same day. The exam subjects include History, Myanmar, English, and Chemistry. We were quite surprised at the high level of English in the exam questions that we were shown. It was noted a tiny cheat book for each test subject is being sold (about 3 x 4 cm and properly bound) and most test takers seem to be using these to take the exam. It is reminiscent of the historic Chinese exams for government officials. Observing the schools, it seemed that girls were studying relatively more seriously.

Fig. 42. High school students on their way home, Kanpetlet.

Fig. 43. Primary school students on their way to school in the rain, Mindat.

Fig. 44. A classroom in a primary school in Hilong village.

Fig. 45. A classroom in an elementary school at Oak Pho village.

Fig. 46. The wife of the National Park ranger U Hong Mang is helping her second son and his classmate study. In the dark, only the candlelight provides some light.

7) Medical Facilities

Fig. 47. A baby with severe burns had been brought in. Only banana leaves have been applied to the wounds. The local homes have rooms with the hearth in it so there are often cases of small children with burns.

Even in a village like Kanpetlet that lacks in so many aspects, we could not overlook the poor medical facilities as it directly affects lives.

Both Kanpetlet and Mindat have hospitals. A young, skilled doctor is assigned from Yangon for a term of two years. This doctor makes his rounds not only in Kanpetlet, but also in surrounding villages. By participating in medical work at such a remote area, they secure the special privilege of being able to participate in overseas training after the two year period.

Several nurses are at the hospital and support the doctor. The doctor's check-up (free of charge) will produce a prescription and medicine can be bought from the hospital or a pharmacy in the town. If hospitalization is necessary for diagnosis in detail, patients can stay at the hospital. There is no meal provision facility among other things, so patients must bring their own bedding and food. They do not charge for beds, but for villagers, the biggest problem is that they cannot pay for medicine. It may be that they make loans within the villages. Children's tuberculosis, malaria that affects both children and adults, burns at the hearth, and children's skin diseases due to limited bathing are very common.

Fig. 48. Likewise, a child with severe burns in Yelongpan village.

A refrigerator donated from Japan (solar powered) had been setup to store children's vaccine. Free TB vaccines from UNICEF have been received by the hospital and some children have had them administered. The X-ray machine is used by turning on the generator. Poor villagers are rarely able to pay for the X-ray.

Fig. 49. A room in Kanpetlet hospital. There is nothing else other than a simple bed. A woman with a diseased liver and sides swollen with abdominal dropsy has been hospitalized. Nothing can be done. The man in glasses is Dr. Kyaw Zay Win

Fig. 50. A check-up of a hospitalized patient.

Fig. 51. A foot-operated medical tool found in the dentistry room.

Fig. 52. Through Japanese ODA donation, a solar powered, top-of-the-line dentistry tool and special chair were installed.

Fig. 53. U Om Ling Htang helping Dr. Thu Ya Soe based in the Kanpetlet hospital.

Fig. 54. Dr. Thu Ya Soe's successor, Dr. Kyaw Zay Wint (left) and dentist Dr. Ko Ko Oo.

8) Availability of Water

Water is drawn from a stream in the mountain valley over several kilometers through a PVC pipe. Each segment is simply fused together with fires lit along the way. There is always trouble, such as connections being split, pipes burnt by forest fires, crushed by wandering Mythun, clogged by leaves and rocks and each of these cause water to stop flowing. To fix this, a tenacious search for the cause of trouble is necessary.

Fig. 55. About two hours away on foot from Oak Pho village, a concrete dam had been made in a mountain stream. This is the source of water supply.

Fig. 56. PVC pipes are tied to trees or supported by forked branches to cross cliffs.

Fig. 57. Pebbles and leaves often end up in the pipes and filtering is necessary.

3. Religion

Shigeo Yasuda, Project Manager

Religion plays an important role for the Chin. Yangon is a prime example. Although most large cities including Mandalay were observed to have seen a decline in the role of religion, the people of the mountainous Chin ethnic group, who live far from cities and with a certain distance from the cash and market economy, religion is part of their daily lives and influences it as much as food production. To sustain the project in the future, the local cultural information must be understood and recorded. As such, an investigation was conducted on the religion of the Chin people, which plays a major role in their daily lives.

Understanding the Current State

1) Spirit Worship

Fig. 1. A Mythun feast that we participated in on the outskirts of Mindat. The sacrificed cow's head and heart are lashed onto a wooden post. February 24, 2008.

All ethnic groups under the Chin tribe traditionally believe in spirits (David & Barbara Fraser 2005). Nat is believed in all areas of Myanmar. Its worship is a form of spirit worship and it is widespread amongst the Chin.

The name Natma Taung (Mt. Victoria) points to its symbolism in Nat worship (the peak, however, has a Buddhist pagoda due to a policy of Buddhism promotion by the current government).

The Mythun feast (a banquet with Mythun, *Bos frontalis*) is the most important festival for the spirit worshipping Chin people. For the banquet, people slaughter Mythun according to their financial capacity and serve the villagers. The skull from the slaughtered cow adorns the front of their house. Houses with more Mythun skulls symbolize their power (Segawa, 2005). Some houses were adorned not only with Mythun but also with skulls of barking deer and bear hunted in the forest.

At the crossroads between the old Myanmar capital of Bagan and Natma Taung, there are many shrines for the Nat god and goddess. Drivers who believe in spirits sound their horns when going past these. Their faith can be seen not only at festivals but in their daily lives.

Fig. 2. The meat is distributed amongst the villagers. February 24, 2008.

Fig. 3. A display of skulls seen on the road from Mindat to Matupi. Being examined is a bear skull.

Fig. 4. Shrines dedicated to the Nat god. On the road between Saw and Chauk.

2) Buddhism

It is thought that traditionally there were few Chin people who believed in Buddhism. However, not limited to Natma Taung, much of Chin State has seen an inflow of Myanmar who have come to conduct public duties (State Peace and Development Council [SPDC], police, medical personnel, Forestry Ministry, Agriculture and Irrigation Ministry, etc.) and live locally. Civilian migration from areas such as Magway has also been observed and these people are without exception Buddhist (Theravada, or in other words Hinayana Buddhism). Also, because of the government's Buddhism promotion policy, in order for one to be promoted above a certain level in public office, one must be Buddhist. This is why Chins who are actually Christian publically professes to be Buddhist to maintain their relative standing in public affairs. Due to these reasons, it is explained that the number of Christians and Buddhists in the Natma Taung region is almost equal. One characteristic of Theravada Buddhism is a deep reverence towards monks.

Fig. 5. Alms giving in the center of Kanpetlet town. Rice and dishes to go with these are provided. January 2, 2008.

Fig. 6. Kanpetlet. A nun asking for alms. The woman paying respects to the nun is a daughter of a Myanmar public officer living in the area. December 13, 2007.

3) Christianity

During the first half of the 19th Century when Myanmar was annexed as part of India under the British, evangelism was promoted to convert animists in the region as part of colonization policy. Initially, Roman Catholicism had taken root and amongst modern day Chin, it seemed Catholics were most abundant.

Aside from Catholics, Baptists, Methodists, and members of the Assembly of God (AG) had their respective churches and are quite active. The priests and pastors of each church make periodic rounds in their parish for missionary work. There was an opportunity to dine with a cardinal visiting Kanpetlet from the provincial capital Haka in the north of Chin State and heard how the cardinal himself was taking great pains to train villagers with agricultural skills so that they can secure daily food supplies.

Fig. 7. Group photo with a visiting cardinal from Haka. April 4, 2009.

Discussions

Traditionally, locals were mostly spirit worshipers, but after colonization by the British, Christianity spread due to evangelism and after the war, government policy led to the rise of Buddhism. In either of these religions, religious events have been incorporated to the daily lives of the Chin with great influence. For example, In Christianity, Sunday mass and grace before meals and participation in Christian festivals (Easter, Christmas, etc.).

In Buddhism, every morning and evening, flowers and prayers are offered to the alter in each home, flowers are offered to Buddha, and alms are offered, for example. As such, for the Chin and other people living in the Natma Taung area, religion plays a large role. Buddhists listen intently to their monks Christians to their priests and pastors. Also, for both Buddhism and Christianity, the clergy make daily rounds to surrounding villages for evangelization activities, but there are no such rounds made to villages by public organizations.

As such, booklets with simple information for the conservation of forest resources, cultivation of forest resources, introduction of agroforestry, preparation methods of fertilizers, etc. (with drawings and text in Myanmar and sometimes Chin) should be prepared and utilized by clergymen as part of their services. It would be the most realistic and effective method for dissemination. In other words, in order to communicate the objectives of the project to the Chin, one method would be to incorporate activities in evangelical activities so that the project would stay hold and local communities would excecute it independent. We would like to propose this for the next project. By doing so, the original project goal of disseminating the efforts from the three model villages to the entire region may be achieved.

Fig. 8. Sunday mass at the Catholic Church. March 8, 2009, Kanpetlet.

Fig. 9. As it gets closer to Christmas, devotees go house-to-house holding candles and singing carols late at night. The two ladies on the right are Buddhists who greeted the carolers.

Fig. 10. There are alters in Buddhist homes and prayers are offered in the morning and evening. December 4, 2007, Kanpetlet.

References

Fraser D. W. & Fraser B. G. 2005. Mantles of Merit. Chin Textiles from Myanmar, India and Bangladesh. River Books Co., Ltd, Thailand.

Segawa M. 2005. Journey to Nusa Tenggara islands, Indonesia. 286 pp. Gaihusha. Tokyo. (in Japanese).

4. Tools (Metal Products)

Shigeo Yasuda, Project Manager

The mountainous Chin people have some unique tools for daily use owing to their long history of making a livelihood out of hunting and shifting (slash-and-burn) cultivation. These are metal combined with hard wood or bamboo and are widely used for hunting, agriculture, cutting and shaping wood, and also for cooking.

1) Production of Tools

There is no smithy in Kanpetlet. The photo is from a smithy in Saw at the foot of the mountain. Heated iron is shaped while sending in air with hand-operated bellows.

Fig. 1. Sending air with a bellow. Saw. February 18, 2009.

Fig. 2. Shaping the heated iron. Saw. February 18, 2009.

2) Tools

A. Machete/Broad knife
Used for cutting thick lumber. A tool that is indispensable for preparing daily firewood supplies.

B. Large Saw (Two-man saw)
Used for cutting down large trees. Also, it is utilized for preparing lumber from cut down trees and it is a very important tool to the local area.

Fig. 3. A park ranger preparing firewood. February 10, 2009, Kanpetlet.

Fig. 4. A machete/broad knife exhibited at an assembly in Mindat. February 18, 2009, Mindat.

Fig. 5. Three park rangers cut lumber. February 10, 2009, Kanpetlet.

Fig. 6. Villagers of Hilong village cutting up a tree that had fallen and blocked a road. August 15, 2007.

C. Curve Knife
Although it was not directly observed in use in Kanpetlet, the knife was sometimes seen. We would like to keep a record. Perhaps it is for severing branches.

Fig. 7. Curve knife. Exhibition at Mindat. February 18, 2009


Fig. 8. Digging Stick. Exhibition at Mindat. February 18, 2009.

D. Hoe/Digging Stick (Temporary name)
This tool is useful when digging holes in hard ground when constructing homes. It is attached to the tip of a hard wooden pole.


Fig. 9. Digging Stick. Exhibition at Mindat. The edge is slightly curved. February 18, 2009.


Fig. 10. Small bamboo basket with Chin knife.

E. Chin Knife
This is a representative tool of the Chin. Town residents have stopped carrying them, but all men without exception from neighboring villages carry them around. Women never carry them. It is hung sideways over the shoulder in a woven bamboo satchel/small basket with woven bamboo rope (as worn by the man in the center of Fig. 5. The design of the longyi worn by the man is also a traditional Chin pattern). The case is also utilized for carrying around any small items like tobacco, lighter, slingshot ammunition for hunting birds, and sometimes even mineral water bottles.

5. Transportation

Shigeo Yasuda, Project Manager

The quality and quantity of the transportation methods available to locals for daily life and transporting goods are an important indicator for measuring the locals' quality of life. In other words, it is a social resource, an infrastructure component that forms the industrial basis. However, for us Japanese who live with one of the best transportation systems in the world, there may be few people who consciously recognize this point. In this chapter, with the belief that understanding the current status of transportation in the Natma Taung area of southern Chin State is crucial information for understanding the daily lives of the locals and neighboring villagers, records of observations and information gathered are presented.

Method

Information gathered about road conditions and transportation methods during the two years of my stay in the local area.

Observations

1) Roads

Kanpetlet-Saw

For the people of Kanpetlet, the road that lives between Kanpetlet and Saw is in daily use. Gasoline, diesel, rice, freshwater fish, coconuts, papaya and other tropical fruits are all acquired by going to Saw or purchasing what had been brought in. Simple automobile and motorcycle maintenance and repair can also be done in Saw.

Fig. 1. Paving the road with asphalt. It is a very simple treatment on which tar is applied over pebbles. August 18, 2007.

The road has been well maintained in the recent years and most of it has been paved. Large trucks with overflowing with teakwood and bamboo do not pass here so there is not much damage to the road. People and goods are being frequently transported by motorcycles. The total time of travel is about 40 minutes.

Saw-Chauk

Chauk is the closest city to Kanpetlet and car and motorcycle parts, PVC pipes for waterworks, and spare parts for generators can all be acquired. Foodstuff of all varieties is also plentiful. The road to Chauk is in painfully bad condition. If this road is properly maintained, the life in Kanpetlet would probably be remarkably improved. One reason why the road is in bad condition is because trucks heavily laden with teakwood traverse it and its wheel tracks heavily damage unpaved roads. It is thought that lightly paved roads also suffer damage very easily and is of no use. Also, the damaged parts of the road become muddy during the rainy season (May to December) and driving becomes very difficult. Also, sometimes a branch of the Ayeyarwaddy River temporarily overflows and it becomes impossible to cross. In this case, there is no choice but to wait for the water to recede.

Fig. 2. A jeep that got caught in the mud left by a branch of the Ayeyarwaddy river. The car is a 1963 Toyota Land Cruiser. May 31, 2009.

Kanpetlet-Entry to the Trekking Route of Natma Taung (Mt. Victoria)
It is unpaved but during the dry season, travel by car is possible. Villagers heading to Kanpetlet from far-flung villages travel across the Natma Taung (Mt. Victoria) and descend this road. During rainy seasons, large trees may collapse and block the road. The road leading to Hilong village is in the same condition.

Fig. 3. Removing a fallen tree blocking the road to Hilong village. August 15, 2007.

Kanpetlet-Yelongpan Village
Originally, the route required descending to the valley and crossing a steel suspension bridge (constructed by the assistance of United Nations Development Programme [UNDP]) then climbing a steep slope for two-and-a-half hours, but a road circumventing the valley was mostly completed in 2009. Because it no longer had great differences in elevation, it became much easier to travel. It is still unpaved and a section requires climbing a steep cliff so it is still impossible to travel by car but it would probably soon be open to motorcycle travel. If this becomes possible, the lives of Yelongpan village residents would be greatly improved (transporting emergency patients and cash crops).

Roads Connecting Kanpetlet and Surrounding Villages
All the roads are very narrow trails and it is almost impossible to bypass oncoming traffic. Villagers travel this road on foot carrying heavy loads for several hours to days to get to Kanpetlet. Many valleys need to be traversed but there are no bridges save lumber that has been thrown over rivers.

Cash crops produced in the village are carried in villages and sometimes Mythuns are taken along for sales. Gaining cash, they return home after buying things like rice, salt, and dried fish (Fig. 7).

2) Transportation Methods

Truck
The road condition between Chauk and Saw is extremely poor so travel with a sedan type car is impossible. It must be done with a high axled truck or at least a four-wheel drive vehicle like Toyota Surf.

There is a weekend round-trip truck service between Chauk and Kanpetlet. A trader based in Kanpetlet operates that truck service. It transports both goods and people.

There are three such trucks in Kanpetlet and a new purchase (of a secondhand vehicle) was reported to have cost 8 million Kyats (about 8,000 USD then).

Fig. 4. A truck that arrived from Chauk transporting a full load of people and goods. A jeep on the left. March 11, 2008.

Jeep
It is also known by the pseudonym “Russian Jeep”. It can carry a limited amount but it is a hight body and suited to the local terrain and there were 5 in Kanpetlet.

Motorcycle
It was originally imported from Japan so it has good performance and an expensive commodity. Since a few years ago, cheaper (500,000 to 700,000 Kyats) Chinese bikes have been imported so the number has suddenly started to increase. In Kanpetlet, there are already about 20. But compared to Japanese products, it is not as sturdy and frequent repairs are necessary. For repairs, it needs to be transported to Saw.

Fig. 5. Gasoline in beer bottles are bought at a vendor for fueling. One bottle costs 1,000 Kyats. August 16, 2007, Mindat.

Horse

Horses were only sighted once. Goods were piled on the horse's back and a procession was made to advance. For transportation in steep mountain paths, horses are probably well equipped. However, we did not see any horses being bred near Kenpetlet. Maybe this is because they did not have the resources to breed horses.

In contrast to the rice producing areas at the foot of the mountain, no cows are used for plowing or transportation in Natma Taung area. The reason was inquired several times, but no clear answer was given. Perhaps it is because of the cultural background of mountain folk, or because hay from rice cultivation is indispensable for cow breeding. In any case, as far as we saw in Myanmar, cows or water buffaloes and rice cultivation were a set and there was no cow breeding in places without rice cultivation.

Fig. 6. Setting off from Kanpetlet with goods piled on horseback. March 8, 2008.

Manpower

Most transportation in Natma Tang is carried out by manpower. Men, women, and children all carry heavy baskets on their backs and strapped to their heads and walk for long, long hours.

This method of strapping a basket to the head is typical of the Chin ethnic group and cannot be observed at all in Saw in Magway region, a town in the foot of the mountain. The ladies in Myanmar usually carry their load on top of their head.

Fig. 7. A group of people who have arrived in Kanpetlet from a far away village on foot. March 21, 2009.

Discussions

If the road between Saw and Chauk can be properly maintained, it is thought to greatly improve the lives of villagers and development of Kanpetlet.

When visiting Mindat, there are many things that can be observed to be better off than Kanpetlet and it seemed almost strange that such a disparity existed in such nearby villages, but this was proven to be caused by impeded transport.

From Mindat, a paved road stretches to Pakokku, one of the largest cities and there is frequent transport in between these two. Almost any commodity can easily be acquired from Pakokku and emergency patients can be relatively easily transported to a general hospital in Pakokku.

As such, if the Saw-Chauk road that connects Kanpetlet and the large city is improved, it is expected that:

1) Abundant life goods (materials and food) can be acquired.
2) Automotive maintenance fees will drop due to very common troubles due to bad roads.
3) Emergency patients can be transported.
4) Cash crops produced around Kanpetlet can be easily exported to cities.
5) Tourist access from Bagan would become easier and tourism incomes would be recieved.
6) Commodity prices will drop due to decreased transportation costs.

On the other hand, some demerits from road development can be presumed. Because transportation becomes easy, all economic activities may be sped up and control of forests may not be adequate. Without adequate control (this is the responsibility of the Ministry of Environmental Conservation and Forestry), the forests' destruction would spread. Currently, in the area of the Natma Taung National Park, it could be said that the remaining natural forests are largely protected by this restricted access to local areas in addition to conservation efforts made by the government.

Chapter III

The Social Conditions of Natma Taung National Park

1. Climatic Conditions – Temperature and Humidity –

Kazumi Fujikawa

In order to introduce a cash crop to the project site, it is necessary to know the conditions of soils, temperature, rainfall, humidity and etc., because chice of crop is dependent upon many environmental factors. To understand what crops are most compatible to the area for cultivation as economic plants, the temperature and humidity are measured here.

Method

At the Natma Taung National Park office, Forest Department in Kanpetlet (21°11′36″N, 94°03′01″E altitude 1,549 m), to measure the temperature and humidity, a data logger was set at one meter above the ground (Fig. 1).

Onset's HOBO H8 Pro SeriesRH/Temp was used for the data logger and installed the logger inside the solar radiation shield. Measurements were taken between June 1, 2007 and July 31, 2008 and the temperature and relative humidity (RH) was measured and recorded every hour. The recorded temperature and relative humidity data was fed into the computer using the software BoxCar Pro4.2.

Fig. 1. The date logger measuring temperature and humidity was set at Natma Taung National Park office.

Results

The record of monthly average temperature, minimum temperature, maximum temperature, average range between maximum and minimum in daily, and average relative humidity (RH) are shown in Table 1. Fig. 2 shows the graph of the average temperature and humidity during the measurement period.

Observing the temperature during the measurement period, the highest was 31.52°C recorded on April 18, 20, and 27 in 2008 with the lowest of 6.62°C recorded on January 28, 29 and February 3 in 2008. In regards to monthly average temperature, December was lowest month at 13.68°C and April was highest one at 22.71°C. For the range in daily temperature, the highest range between maximum and minimum record was on February 15, 2008 at 14.26°C and lowest recorded level was on May 15, 2008 at 1.14°C.

Relative humidity was low in March and April at 48.04 % and 49.57 % respectively, but exceeded 80 % during the period between May and December.

Table 1. Average temperature, minimum temperature, maximum temperature, average of the range between maximum and minimum temperature of daily basis and average humidity each month during the measurement period between June 1, 2007 and July 31, 2008.

Month	Average Temperature /month	Min. Temperature / month	Max. Temperature / month	Average Range Max.– Min.Temperature / month	RH(%) Average/month
June, 2007	20.78	16.76	27.12	5.31	86.96
July, 2007	19.97	16.76	25.95	4.61	95.48
Aug., 2007	19.51	16.38	25.17	4.49	98.59
Sept., 2007	19.07	14.85	26.73	4.47	97.72
Oct., 2007	18.05	13.70	24.79	5.34	97.36
Nov., 2007	15.56	9.82	22.48	5.07	94.22
Dec., 2007	13.68	7.43	22.86	7.00	80.01
Jan., 2008	13.79	6.62	22.48	8.12	72.04
Feb., 2008	14.75	6.62	26.34	9.83	62.29
Mar., 2008	19.59	11.38	29.50	9.66	48.04
April, 2008	22.71	14.85	31.52	9.13	49.57
May, 2008	20.33	16.38	27.12	5.81	80.39
June, 2008	19.81	17.14	24.79	4.61	94.89
July, 2008	19.88	16.76	25.17	4.43	95.55

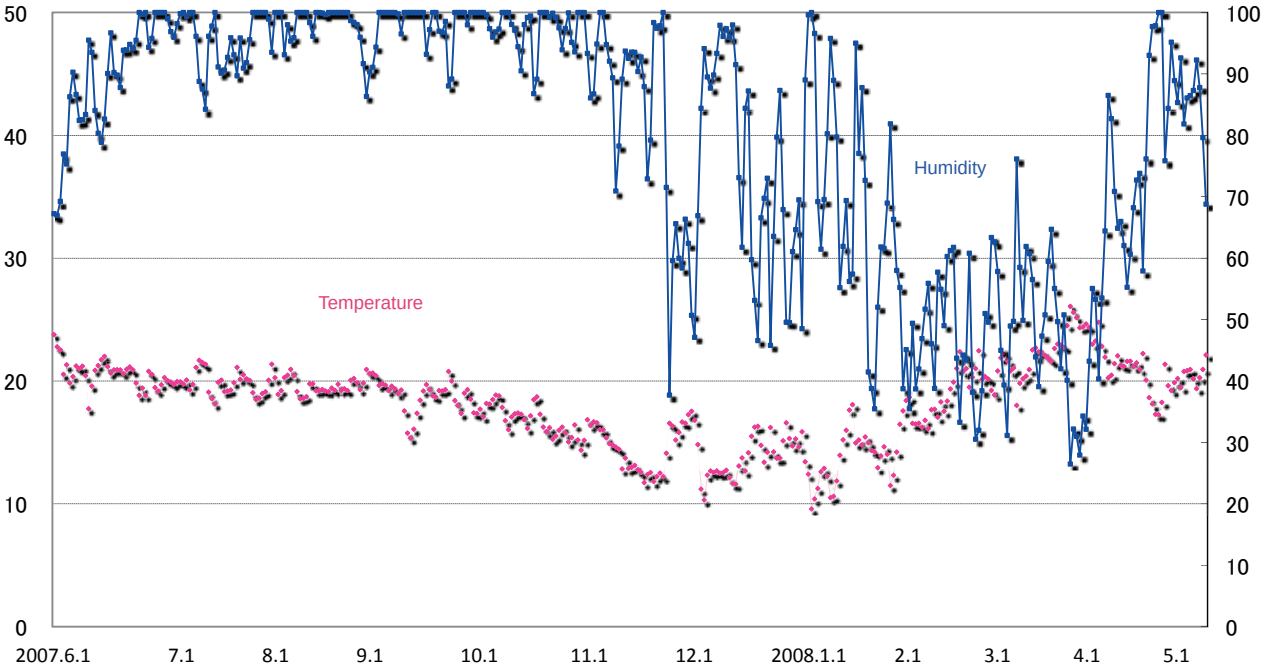

Fig. 2. Temperature and humidity at Kanpetlet. The data shows daily average temperature and humidity (from June 1, 2007 to May 31, 2008). The red line indicates temperature and the blue line shows humidity.

Discussions

It is reported that the project site, Natma Taung National Park, has a heavy rainfall during the rainy season, as southern Chin State is heavily influenced by the monsoon (David & Barbara Fraser, 2005). Above the border with the Magway Division (altitude 700 m) to the summit of Natma Taung (Mt. Victoria, 3,053 m), residential areas are concentrated into the areas of altitude at around 1,200 m. During the measured period, although it was only a year long, the monthly average temperature did not show below 13°C and the high was no more than 23°C so it could be a mild temperature. The season throughout the year is divided into three parts; rainy season, cool dry season, and hot dry season. The rainy season starts from middle and/or late May to early December when humidity was recorded to surpass 80 %. From middle of December to February is the cool dry period when both temperature and humidity is low, and March and April has higher temperatures but with low humidity, and therefore proven to be the hot dry period.

Rainfall and intensity of solar radiation were not measured. According to the measurement records, however, it can be supposed that there is heavy rainfall and limited sunlight during the rainy season. Also, during the rainy season, between July and September, there is a quite narrow daily temperature range between 4-5°C, it is thought that cloudy weather continues over the period (even if lower land is sunny, mountainous areas would be enveloped in clouds). This point of view was confirmed with the resident Japanese project manager.

In regards to cash crops being introduced, as the average temperature in dairy does not show below 10°C even during the coldest month and the coldest recorded temperature being above 5°C, it seems that the frost doesn't cause damage to the crops cultivated this area. Therefore, it should be possible to introduce and cultivate plants, fruits, and tea varieties native to warm temperate zones, but herbaceous plants would need to be selected based on its compatibility to limited sunlight during the rainy season.

References

Fraser D. W. and Fraser B. G. 2005. Mantles of Merit: Chin Textiles from Myanmar, India and Bangladesh. River Books Co., Ltd, Thailand.

2. Production Conditions

Mitsuo Matsumoto

Chin State is in the mountain region and even in Myanmar, where shifting (slash-and-burn) cultivation is wide-spread, the area is known to have an especially high prevalence of this practice. With rising population pressure, the productivity of shifting cultivation has continued to decline. Therefore, converting shifting cultivation to permanent fields and maintaining and improving soil fertility are becoming an immediate priority. In order to make up for decreasing food productivity and secure cash income sources in the face of a collapsing self-sustained economy, the introduction of appropriate cash crops is highly demanded. For JICA Partnership Program, Kanpetlet Township in the Natma Taung region in southern Chin State was selected. In this area, potential cash crops were chosen from local forest resources such as medicinal orchids (*Dendrobium*), Myanmar konjac (Wa-U), and relatively easy to cultivate medicinal plants (adlay and sicklepod), and their introduction and technology transfer for cultivation was attempted.

For new crops and techniques to locally take hold, the prerequisite is that the relevant production and social conditions are in place. Therefore, it is necessary to clarify what conditions are necessary to form the basis of cash crop introduction and cultivation skill transfer.

In the present research, the soil conditions, climate, and agricultural tools in the Natma Taung region will be investigated. As climatic information is to be reported in a separate section, results of soil conditions and agricultural tools will be reported here.

Method

1) Environmental Conditions

In May, August and December of 2008 and between February and March 2009, data was collected by the dispatched researcher through experience and oral and visual records.

Fig. 1. Soil survey (Village-gate field).

2) Soil Conditions

The research was conducted in May 2008 in five sites: A) Oak Pho field where a Japanese cultivar of adlay and a sicklepod cultivar were cultivated; B) Village-gate and C) Lower Land-1 fields that were cultivated sicklepod; D) Lower Land-2 field where adlay was cultivated; E) Yelongpan field where Wa-U was cultivated [here only chemical properties of the top soil was conducted)] (Fig. 1). Representative plots were chosen from around the center in each of the fields and a hole of about 1m width and 50cm depth was dug to observe the soil profile and samples for chemical analysis were collected from the top soil and the subsoil. Soil profile survey was done according to the soil profile survey checklist from the Japanese Ministry of Agriculture, Forestry, and Fisheries (MAFF) for soil conservation. The chemical property was analyzed for monitoring soil functions according to analysis methods for soil, water, and organic matter set forth by the Japan Soil Associatoin.

3) Agricultural Technology

The condition of agricultural fields, state of maintenance, tools in use, and the kinds of crops being cultivated were recorded and observed when visiting Oak Pho, Yelongpan, and Old Kanpetlet villages in Kanpetlet Township and Hilong village in Mindat Township.

Results

1) Environmental Conditions

The settlements of Kanpetlet is laid out along the ridge halfway up the Natma Taung (Mt. Victoria, 3,053 m). Within the town there are widely scattered village communities along the mountain slopes, fanning out from the central town. The homes in each village community have small to medium sized home gardens and around the village are slash-and-burn fields or permanent fields. The fields dot a wide area between an altitude of just few hundred meters among Depterocarpaceae forests and high altitude areas with high humidity and persistent fog at altitudes of around 2,000 m.

Fields are mostly situated on an incline between 3-8 degrees (some risk of soil degradation) to 8-15 degrees (high risk of soil degradation). Slope grades of some fields were very steep at 15-25 degrees (very large risk of soil degradation and recognized to be difficult to use for cultivation).

In regards to climatic conditions, it is as reported in the results section of this current investigative report. Low altitude areas near the state borders were thought to receive more sunlight, having higher temperature, and less rainfall during the rainy period in comparison to areas at high altitude. The crop season began in May and ended in October. In this period, areas at high altitude were enveloped in mist in the morning and almost daily rainfall was observed in the afternoon. However, there is no record of the amount of rainfall during this period. It is said that almost no rain falls between November and April.

2) Soil Conditions

The reddish-brown soil found in this area was formed by a strong weathering of alkaline parent material. The results of soil analysis are shown in Tables 1 and 2.

A. Oak Pho field. The soil is claylike and rich in humus and dark in color. Gravels are absent and the soil has good granular and crumb structure, high permeability, and thus a favorable soil condition overall for agriculture. High in cation exchange capacity (CEC) and low in base saturation rate, and no particular problem with salinity and pH was weak in acidity. The phosphate absorption coefficient was very high at a 1,000. The Truog's phosphate content was slightly low and had a characteristic which made phosphate fertilizers less effective.
B. Village-gate field. The soil is loamy and the topsoil has little gravels. The degree of development of the structure is moderate, high permeability, good condition for agricultural use but the density of the subsoil is a little high and there is little prevalence of roots. CEC was high and low in base saturation rate but pH was weak in acidity. Calcium content was low and there is some risk of Ca deficiency. The phosphate absorption coefficient was high at 1,000.
C. Lower Land-1 field. The soil is loamy with a lot of sand and easy to till with high permeability and has good physical condition, but needs fertilizer and irrigation maintenance to make up for its weakness in water retention and fertility. CEC was high with low base saturation rate but pH was weak in acidity. There were no problems with base salinity levels and Truog phosphate content. The reason why the Truog's phosphate content in the subsoil was remarkably high is unknown.
D. Lower Land-2 field. The soil is loamy with little sand. Humus content is low and the subsoil is quite compact so organic fertilization and deep plowing may be necessary to improve the condition. The chemical properties were similar to those of Lower Land-1, but it had low calcium content and a need to look out for deficiency.
E. Yelongpan field. The chemical properties were similar to those of Oak Pho.

Table 1. Soil profiles of trial fields

Field	Horizon	Depth (cm)	Soil color	Soil texture	Humus	Stoniness		Soil structure		Compactness (mm)	Plasticity	Stickiness	Water permeability
						Shape	Content	Type	Grade				
Oak Pho	Topsoil	20	5YR3/2	CL	Rich	Angular	Poor	Crumb	Strong	<10	Moderate	Moderate	Permeable
	Subsoil	60	5YR3/2	CL	Rich	Angular	Poor	Granule	Moderate	11～18	Moderate	Moderate	Moderately
Village Gate	Topsoil	16	5YR3/4	L	Moderate	Angular	Poor	Granule	Moderate	<10	Moderate	Moderate	Permeable
	Subsoil	43	2.5YR4/4	L	Poor	Angular	Poor	Granule	Weak	19～24	Moderate	Moderate	Moderately
Lower Land-1	Topsoil	18	10YR3/4	SL	Moderate	Angular	Moderate	Granule	Moderate	<10	Weak	Slight	Permeable
	Subsoil	41	10YR6/6	CL	Poor	Angular	Rich	Block	Weak	11～18	Moderate	Moderate	Moderately
Lower Land-2	Topsoil	13	7.5YR3/4	L	Moderate	Angular	Moderate	Granule	Weak	11～18	Weak	Moderate	Moderately
	Subsoil	>60	5YR5/6	L	Poor	Angular	Poor	Block	Weak	19～24	Moderate	Very	Slightly

Table 2. Chemical properties[Z] of soils from trial fields

Siol[Y]	pH(1:1)	EC	ex.K_2O	ex.CaO	ex.MgO	CEC	BCSR	Troug's P_2O_5	PAC
		μS	mg/100g	mg/100g	mg/100g	me/100g	%	mg/100g	mg/100g
Oak Pho Ⅰ	6.0	33	37	132	21	35.3	18	8.3	1073
Oak Pho Ⅱ	5.8	17	7	56	9	17.3	15	1.6	811
Village-gate Ⅰ	6.1	57	99	67	34	29.8	21	15.6	902
Village-gate Ⅱ	5.4	30	42	14	7	25.2	7	8.8	1033
Lower Land-1 Ⅰ	5.9	44	37	124	29	30.4	22	7.8	615
Lower Land-1 Ⅱ	5.5	16	17	15	7	16.4	8	81.4	524
Lower Land-2 Ⅰ	6.1	40	33	89	16	20.6	23	2.6	438
Lower Land-2 Ⅱ	5.7	20	15	30	8	13.1	13	12.1	415
Yelongpan Ⅰ	5.7	121	46	181	38	39.6	24	3.8	1235

[Z] CEC:Cation Exchange Capacity, BCSR:Basic Cation Saturation Ratio, PAC:Phosphate Absorption Coefficient

[Y] Ⅰ:Topsoil, Ⅱ:Subsoil

3) Agricultural Technology

For the shifting cultivation, the only tools that are used are cutlasses for cutting grass and wood and a stick for making a planting hole. In other words, corn is just sown into a hole (Fig. 2). On the other hand, regular use for uplands has been setup around homes and long-handled hoes are used here. Regular use fields are also not implemented as a proper terracing, but simply a hillside farm over an unknown area of land. The main produce from their fields is corn. Aside from this, coix seed, Wa-U, leguminous vegetables, tea, and fruits (citrus) were also being cultivated. Most families have a home garden. Its area is not so large. Here, vegetables, fruits (citrus, avocado, jackfruit), industrial crop (castor seed), Wa-U, flowers and trees were observed to be cultivated.

Fig. 2. Planting corn.

Discussions

1) Environmental Conditions

It is said that “the Asian shifting cultivation’s farmers all live in the mountain,” and Chin State is a prime example of this with shifting (slash-and-burn) cultivation being very popular. The Natma Taung National Park in the south of Chin State is in a mountainous region with Natma Taung in its center. Its climatic conditions were markedly different according to altitude. Especially the volume of solar radiation and temperature during the farming period in the rainy season is thought to greatly influence the choice of crops for cultivation. For example, for the trial results in this project, sicklepods were decimated in high altitude Oak Pho village.

Climatic data would be the base from which crop selection for local introduction would be made.

This time, temperature and humidity data for one year has been acquired, but gathering rainfall and solar radiation data is also a pressing priority.

2) Soil Conditions

The main soil type in the Arakan mountain range is reported to be NT. NT is one of the soil groupings used in the "WRB Map of World Soil Resources" of the Food and Agriculture Organization (FAO) and soil types included in this grouping include Nitisols (clay found all the way to the lower layers with aggregate structures) found widely in high altitude tropics and Andosols (volcanic ash soil high in aluminum content, preventing crops from absorbing phosphate), both produced by the strength erosion of alkaline parent materials or from volcanic ash.

The fields under investigation had high Cation Exchange Capacity (CEC), low in base saturation with weak acidity. The content of exchangeable potassium and magnesium were rather high, through which the effect of shifting cultivation (ash from grass and trees) could be observed. On the other hand, calcium content was low and care was needed against deficiency. The soils of Oak Pho, Village-gate, and Yelongpan fields had slightly high phosphate absorption coefficients over 1,000 which suggested the mixture of volcanic ash. Allophane content in volcanic ash needs to be measured. In either soil, inorganic nitrogen was not detected and nitrogen fertility was projected to be low.

From the results, these fields were deemed to possess the minimum required soil fertility except nitrogen. In order to maintain the productivity as a regular used field, it is most important to supply nitrogen fertilizers and phosphate and calcium. Specifically, it would be most practical to produce fertilizer from the manure of chicken and pig that is being widely bred in the area. For this, quitting free range breeding of small numbers of cattle would be necessary towards conversion to the house rearing and feed production to increase the number of cattle bred. It is hoped that promotion of the livestock farming would strengthen and sustain farming and also add to the resident's nutrition and cash income.

3) Agricultural Technology

Cultivation areas of mountain dwelling tribes have been transitioning from home gardens to shifting cultivation, then to terraced fields or paddies for regular use. The Chin people's practices such as slash-and-burn agriculture and home gardening did not develop too much, with slash-and-burn still the main method of cultivation. Even fields for regular use are rarely terraced and cultivation, fertilization, and watering are rarely done with crop residues burnt (for utilizing plant ash and eradicating pests and weed). The only cultivation skill is planting tuber crops using digging sticks, remaining at a level of root cultivation culture. This may be due to limited skills and resource accumulation but perhaps the steep landscape has also prevented the introduction of new techniques. In fact, in adjoining flatland paddies, tractors for plowing and irrigation by engine pumps, hulling and polishing of rice by machinery is starting to take hold.

As a direction for improving agriculture in Natma Taung, capable tools (plows, hoes) should be introduced for terraced cultivation and weeding with green mulch would be the key. Also, the use of lateral space and daily maintenance would make home gardening highly productive in the humid tropics. Their further enhancement would be the remedial measure for the time being.

As the rainy season is the season for growing crops, but it is expected that the yield of crops is heavily influenced by rainfall and soil fertility. That is why crops like corn, which is tolerant against water stress and poor soil, is being selected by the locals. It is thought that varieties are also being selected to match such an environment, but in fertile soil, the corn stalks had reached more than 3 m. So, a variety that had not been improved with low yield to stalk ratio seemed to be in use.

In conclusion, it was possible to understand the overall condition of agricultural production in the Natma Taung region. The area is demanding increased productivity, regular use of fields, and the introduction of cash crops due to population pressures and the spread of a cash economy. For its success, appropriate cultivation on appropriate land with the increasing and sustaining of soil fertility is imperative. Collection of basic data such as climate and soil type that defines the production condition must be continued. Moreover, capable tools must be introduced and selective breeding and improvement of crop varieties seems necessary.

3. Shifting Cultivation

Shigeo Yasuda, Project Manager

The residents of the area in and around Natma Taung National Park in southern Chin State are divided between those in the regional political and economic centers of Kanpetlet and Mindat and those living in villages around the Park. The formers enjoy life of more or less integrated into the cash economy, including the existence of a periodic truck transport between large cities like Pakokku and Chauk but not involved in agriculture except for limited production for self-sustenance.

On the other hand, the latters of surrounding villages (from villages about one hour to three days on foot from the town center) rely on shifting (slash-and-burn) cultivation in the mountain and forests and strongly influenced by self-sustenance needs (i.e. not integrated into the cash economy). While they cultivate staple foodstuffs like corn for self-sustenance through shifting cultivation, they participate in road construction, cultivation and farming of commodities, and harvesting from the forest to acquire cash.

To understand the reality of shifting cultivation is to understand the lives of local residents. Therefore, to acquire basic knowledge prior to engaging in forest conservation and resource cultivation initiatives, a study on shifting cultivation was conducted.

Method

At the outskirts of Kanpetlet in the Old Town village, observation was conducted on the following activities:
1) Clearing the forest (began in December 2008 and ended on February 16, 2009)
2) Setting the fire (March 1, 2009)
3) Planting corn (March 3, 2009)
The realities of each activity were confirmed and photos were taken. Also, the village head was interviewed regarding the overview of their village and the status of shifting cultivation.

Results

1) Clearing the Forest

Clearing the forest was taken place after the beginning of the dry period from December to February in the following year. It is important for the felled trees to be sufficiently dry and thus it usually requires about two months since the time they are felled until they are put on fire. When putting them on fire, to prevent the spread of fire to nearby mountains and residences, grass and fallen trees are carefully removed from around the targetted area.

Fig. 1. Cutting grass prior to setting fire to prevent over-burning.

Of the felled trees, large trees that are suited to use as building materials and big branches for firewood are stacked up and dead grass removed from around it so that it would not get caught fire when fire is set.

Fig. 2. Branches stacked up for use as firewood.

2) Setting the Fire

Fire is set on a day with no wind. The forest area set on fire this time was right near village residences so care was especially taken so that the fire would not spread. Two villagers with torches set fire on the upper slope and let the fire spread downwards. A flame few meters high erupted and spread furiously, suddenly lighting up even the leaves on the highest branches of large un-felled trees. The target area of about 200 meters squared was completely burned up in just about an hour.

Fig. 3. Setting fire with torches.

Fig. 4. Flames few meters high.

3) Planting Corn

The planting was conducted two days after the burning. The ground was covered with ash and heat from the fire remained. Corn seeds (last year's harvest) in a basket hung from the villagers' shoulders were sown in the ground, about three at a time, by using a strong, long wooden pole (about 1.6 m) to bore a hole in the ground and nimbly throwing the seeds in. After throwing it in, no effort is made to cover it up with soil or to water them.

Fig. 5. Planting corn on the burned slope.

Discussions

Fig. 6. There are instances where orchids growing on large trees caught fire.

The field where we observed the farm work this time was a forest that had been untouched for 30 years and all the trees that were felled were large (more than 15 m high with diameters around 50 cm at breast height). We were informed that it was getting rare these days to fell such mature forests and burn it. Fields that had been allowed to fallow for a sufficient period yielded a lot of ash after burning and ash from large trees are highly nutritious. Furthermore, because the trees had provided a lot of shades, there is little weed growth and therefore easier to cultivate after conversion to a field.

In the investigated area, population growth*[A] has contributed to the shortening of fallowing periods, which at 10 years ago was about a 10 year period, currently down to about 4 years. As such, the harvest

from the same area of land has supposedly decreased to about half of what it used to be. This situation has exacerbated a bad cycle that promotes further slash-and-burn and shorter fallowing periods. Shifting cultivation itself is actually not the root cause of deforestation, but can be described as "a culture that has been developed through a very high-level understanding of the forest ecosystem" (Shirasaka 2004). The shifting cultivation in this area was probably originally the result of a balanced union between nature and people's daily lives. However, population growth and the decrease in the area of land owned by villages due to the National Park designation in 1994, the balance has been broken and deforestation (prevention of forest regeneration) is spreading.

*A) Kanpetlet used to be close to Old Town village until it was moved to its current area in 1973. We were pointed to the location of the former Kanpetlet town hall and other sites that were now grassland. The population back then was about 500, but as of 2009 it is said to be over 3,500. Villagers from nearby are also rapidly moving to Kanpetlet due to information that electricity will be available with new hydropower development from next year, although it is unknown whether this would be realized or not.

References

Shirasaka S. 2004. Shifting cultivation in a tradition of the Jinuo people in Xishuangbanna Dai National Autonomous Prefecture (Yunnan Province, southwestern part of China). Journal of Geography 113(2): 273-282 (in Japanese).

4. Description of the Model Villages, JICA Partnership Program

Shigeo Yasuda, Project Manager

Oak Pho Village

Village head: U Mang Naing (41 years old)
Location of the village: Altitude about 1,650 m
Distance from central Kanpetlet: About 1 mile and 4 furlong (about 2.4 km)
Number of households: 35
Total population: 210
Staple crop: Corn
The total harvest does not meet the annual demand so rice is bought from Kanpetlet.
Shifting cultivation: Previously, shifting cultivation was conducted in the forest, but as the forest was designated as a national park, operations have moved to the current area. Therefore, shifting cultivation is currently not conducted and each farmer manages their permanent allotted field.
Means of cash income: 1) Sales of pig and chicken
2) Cultivation of cash crops: potato, Myanmar konjac (Wa-U), lime, and coffee
3) Pine wood lumber
4) Carpentry (Village head, etc.)
Annual cash income: Average of 100,000 Kyats per household
Cattle breeding: 1) Pigs (only a few families, bred in a cage)
2) Chicken (almost all families)
Educational facilities: Primary school only
Religion: Christian (Baptist) – A Church in the village
Access: 20 minutes on foot from Kanpetlet

Fig. 1. A newly ploughed field for the cultivation of adlay and sicklepods. In the foreground are fully bloomed plums blossoms. February 18, 2008.

Fig. 2. The Baptist church at the entrance of the village and kids playing with rocks.

Fig. 3. A ranger (U Hong Mang) giving instructions for slicing konjac tubers in front of the house of the village head. December 10, 2008.

Fig. 4. A group photo after completing instruction for Myanmar konjac (Wa-U) tubers planting. March 23, 2009.

Fig. 5. The villagers came to hold a farewell party for the project manager with three chickens in hand. The man in the far right of the back row is the village head, U Mang Naing and his wife is on the far left of the same row. May 24, 2009.

Yelongpan Village

Field survey: March 24, 2009
Village head: U Shein Om (35 years old)
Agricultural leader: U Om Mana
Location of the village: North latitude: lat. 21°13'04"
East longitude: long. 94°03'39"
Altitude: 5,040 feet (about 1,536 m)
Distance from Kanpetlet: 2 miles and 4 furlong (about 4 km)
The village lies a little below the mountain ridge on the southern slopes with plenty of sunshine.
Households: 37
Total population: 242 (114 men, 128 women)
Staple crop: Corn from shifting cultivation
The harvest is not sufficient to meet annual demand so rice is bought from Kanpetlet.
Shifting cultivation: Designated mountain and forest areas are 600 acres. Fallowing period is about 5 years.
Means of cash income: 1) Sales of pigs and chicken
2) Cultivation of cash crops: potato, castor oil plant, Myanmar konjac (Wa-U) (harvested from the forest), avocado (4 families), turmeric, coffee (1 family)
3) Pine wood lumber
4) Carpentry (1 family)
Annual cash income: Average of 100,000 Kyats per family
Cattle breeding: 1) Pigs (10 families)
2) Chicken (All families)
3) Mythun (7 families, 15 cows)
Educational facilities: Primary school only (40 students)
Religion: Christian (Baptist)
Access: It used to require a 2 and a half-hour journey through a deep valley from Kanpetlet, but a flat road that goes around the village was nearly completed in May 2009. It should be in the near future when motorcycle travel to and from Kanpetlet would be possible.

Fig. 1. Yelongpan village seen in the distance from Kanpetlet. The white roof in the center is the church.

Fig. 2. The forest just north of the village. This community path lies in the forest and leads to villages in even deeper areas. The forest on one side is thought to be a primary forest. Both epiphytic and terrestrial orchids are abundant.

Fig. 3. An orchid nursery built for this project near the Baptist church. Kanpetlet can be seen on the mountain ridge in the background.

Fig. 4. Villagers and children. Most of the children are barefoot and the state of sanitation is poor.

Fig. 5. Villagers listening to the explanation of the project made by U Shein Gay Ngai, the park warden at an assembly. Elder women have tattoos on their faces. The man in the front row with the blue t-shirt is the village head.

Record of Visit to Yelongpan Village

Fig. 1. Yelongpan village seen in the distance from Kanpetlet prior to setting off in the morning. The fog descending from the mountain behind it is about to engulf the village. The village is situated on the southern slopes with plenty of sunlight.

Field survey: January 12, 2008 (Saturday) 7:00 to 16:30
Accompanied by: U Hong Mang, U Om Ling Htang
Record keeper: Shigeo Yasuda

1) Medicinal Orchid Nursery

The park ranger, U Hong Mang's supervision was very effective and the two designated villagers have maintained the orchard well for the past four months. On the day we were able to meet one of the two and paid the maintenance wage for four months (September to December, 10 US dollars per month for four months = 40 US dollars). Currently 270 logs/wooden poles are hung up with 800 orchids growing on them. All were collected from nearby mountains.

2) Agroforestry

Although we could not observe orchids in bloom, it was truly awe-inspiring that there was so much diversity of orchids in the forests just two hours away from Kanpetlet.

The warden of the National Park, U Shein Gay Ngai, wants to conserve this forest as an Arboretum. It can be said to be an ideal spot for tourists interested in orchids and visiting Natma Taung (Mt. Victoria).

As a JICA Partnership Program, there is an immediate need to decide what kind of initiatives should be implemented in the next two years. U Shein Gay Ngai told us that "in order to proliferate orchids in the future, it is necessary to collect new samples now," but we replied saying that "we need to discuss with MBK and decide so please wait a little."

As an aside, the two signs we put up in the past (JICA-FD-MBK Project Agro-Forestry Area) was still safely standing.

Fig. 2. The signboard photographed on August 11, 2007.

3) Wa-U, Myanmar Konjac Cultivation

Some of the tubers planted in July of the previous year were dug up and checked. All of them were found to have been planted too deep.

As there was no potential for good growth as is, villagers were requested to dig up all Wa-U tubers at this point and saved for replanting it again around May.

In the next planning, ridges should be made properly in a straight line and intervals between tubers specified. Because last year's planting was done without specified intervals, there is a chance that the tubers would be damaged by a hoe when digging them up (an example from Oak Pho village).

Currently, Wa-U tubers harvested from the mountains were carried in a basket to Kanpetlet and sold for 500 Kyats per one viss. Because

Fig. 3. Test harvest of planted Wa-U tuber. January 12, 2008.

villagers needed instant cash to buy food and medicine, some claimed that they did not have time to process the tubers, but if they kept up the current situation, they would never be able to save money and they would not be able to escape from scraping a living day by day.

A communal drying hut with a slicer installed was proposed to be constructed. The benefits of processing tubers, through sun-drying and slicing, was explained and the villagers were convinced after arguing that it would make it easier to carry and that it would increase cash income due to added value.

Fig. 4. Same day as above. U Hong Mang on the left and U Om Ling Htang in a white cap.

4) Field Survey of Living Conditions

Dr. Fujikawa interviewed villagers in February of the previous year and its details are recorded in the report (Investigation Results of the Field Survey for JICA Partnership Program. A further field survey was conducted on points that needed reconfirmation according to the report (The village head was absent and 10 villagers were gathered).

A. The village moved to its current location just five years ago. Therefore, the current situation is that cultivation in general is not well established yet.
B. Population: 230
C. Homes: 33; Households: 35
D. Religion: Christian (Baptist)
E. Distance from Kanpetlet is 2.5 hours on foot. The 1.5 hours marked on Dr. Fujikawa's report is only possible if a young person walks rather quickly. Personally, this researcher needs 3 hours including some rest.
F. Elementary school: 40 students (5 to 15 years old). Students stay in Kanpetlet if they move on to high school.
G. Cash crops: As in Dr. Fujikawa's report, nothing is being cultivated. This point is especially economically less competitive compared to Oak Pho village. Oak Pho village produces coffee beans, potatoes, avocado, and lemons and a little cash income can be made by selling them at Kenptlet just 30 minutes away on foot, whereas Yelongpan village is far and making such sales impossible. The only example of a cash crop was turmeric, which is being taken to Kanpetlet and sold for 400 Kyats per one viss*(raw) or 1,000 Kyats per one viss (dried).

*)Myanmar weight 1 viss = 3.6 lbs 1.63 kg

3) Hilong Village

Field survey date: February 27, 2009
Village head: U Ling Om (35 years old)
Households: 74
Total population: 378 (168 men, 210 women)
Religion: Roman Catholic
Educational facilities: Primary and Junior High School
Staple crop: Corn. The total harvest does not meet the annual demand so rice is bought from Mindat.
Cash crops: Potatoes, coffee, castor oil plant, avocado
Shifting cultivation: Fallowing period: 4-5 years (used to be 10 years in the past.)
1,200 acres are designated for shifting cultivation
Cattle breeding: 1) Chicken (all families)
2) Pigs (50 families)
3) Mythun (10 families own a total of 30. A single cattle's market price varies but it is between 200,000 and 300,000 Kyats)
Annual cash income: 10,000 to 300,000 Kyats per family (selling a Mythun brings in large income)

Fig. 1. Near the entrance to the village. To conduct an experiment in which medicinal orchids would be transplanted on to naturally growing trees, advice for picking the best location was sought from cultivation experts from the Queen Sirikit Botanic Garden (QSBG) in Thailand. From the left, Mr. Paisan Thongsorn (QSBG), U Shein Gay Ngai, U Htun Pe (ranger), villager, U Om Kuy Shein (ranger), villager, U Kyaw Swar Lin (translator), and Mr. Yuzo Tanoue. July 3, 2007.

Fig. 2. Group photo after planting *Paris yunnanensis*. The building in the background is the assembly hall. June 21, 2007.

Fig. 3. In front of a home. The former village head at the far right was cultivating medicinal orchids based on the training he received in Kanpetlet in the previous month. June 21, 2007.

Fig. 4. After completing an interview with the village head, U Ling Om. February 27, 2009.

Fig. 5. Day of departure. We assisted the girl in the foreground to receive medical treatment at a hospital in Mindat. As a sign of gratitude, textiles were presented to us. A photo with her family. May 17, 2009.

Chapter IV

Outcomes of the Project

1. Economic Plants

Inventory Research: Kazumi Fujikawa
Research for Chemical Component Analysis:
Minoru Okada, Ayaka Tsujii, Satoshi Shimomoto

Introduction

Fig. 1. Drying the flowers of *Rhododendron* to make wine.

The Natma Taung National Park in the mid-west of Myanmar was designated as a national park in 1994 owing to its diversity of flora and fauna, and water resources. The rich nature remains to this day (Mill 1995, Tanaka 2005, Fujikawa et al. 2008). It seems reasonable to suppose that there are many plants with economic value. Local villagers have collected economic plants growing in National Park for their daily use and as an alternative income to farming. For example, aside from using wood for building materials and firewood, some villagers make wine from *Rhododendron* (*Rhododendron arboreum* Sm.) (Fig. 1) and *Docynia indica* (Wall.) Decne., and/or collect mushrooms and bamboo sprouts to sell in the market.

It can be said that the forest provides non-agricultural natural resources, food, medicine, spices, and building material. However, it is an area where expert researcher has not been conducted yet. There are no reports of just what kind of plants are being utilized by the villagers, or how much value the plants from the Natma Taung have in the market in Myanmar and if such crops are available for export to overseas markets like Japan and China. Therefore, an inventory research was conducted to cover basic information such as: 1) what plants grow the area; 2) which plants have medicinal properties; 3) what plants are being consumed by local villagers as medicine or food; 4) chemical analysis of plants identified in (2) and (3); and 5) to consider in comprehensive way by assessment of resource availability through an inventory research. A vast number of specimens were collected, but for this paper, we will report only on the results obtained within the scope of JICA Partnership Program.

Materials & Methods

1) Collecting Specimens

Fig. 2. Preparing the specimens in the field led by Dr. Prachaya, QSBG.

Field work was carried out three times in Natma Taung National Park and its surrounding areas between February and March and May 2007, and between July and August 2008. Specimens were collected, noting GPS data to provide accurate information about the point of collection onsite and photos taken for habitat records onsite (Fig. 2). Also, plants with potential medicinal properties for chemical component analysis were collected and then were sun-dried and taken back.

2) Interview

Over four days between 28th February and 1st to 3rd March 2007, interviews were conducted in a village in Kanpetlet Township regarding plants being used as medicine or as vegetables and fruits for food. The survey was carried out in the following four villages: A) Oak Pho village; B) Yelongpan village; C) Thalong Pan village; D) Kanthar Yan village. Oak Pho and Yelongpan villages are model villages for the JICA Partnership Program (please refer to details in Chapter 3). Thalong Pan village lies within a national park at an elevation of 2,000 meters and is situated about 20 minutes down a slope south of an unpaved

road (about 12 miles from Kanpetlet) that lies before the base camp of a mountaineering trail connecting Kanpetlet and Natma Taung (Mt. Victoria). Kanthar Yan village is about 20 minutes down the western slope from the mountain ridge running through Kanpetlet, and was situated here from before Kanpetlet town moved to its present location. In all villages aside from Oak Pho, villagers gathered at the residence of the village head to be surveyed, while in Oak Pho, the village head introduced each household for implementing the survey. Japanese-Myanmar translation was conducted, but for older villagers who did not speak Myanmar and only spoke a Chin dialect, the village head was requested to conduct the translation between Myanmar and Chin (Fig. 3). The questionnaires were about plants being used for medicine or food. Plants that villagers used as resources were collected as voucher specimens, as far as possible. Basic data about the location, population, and religion of surveyed villages were also recorded.

Fig. 3. Interview of the midwife of Oak Pho village.

3) Selection of Medicinal Resources and Candidate Species

In regards to plant species with potential as medicinal resources (potential as alternative crude drug used in Japanese pharmacopeia), providing they were the same species being used as herbal medicine in Japan or were closely related species being used as folk remedies, they were selected as candidate species. Species that have existing medicinal use in Myanmar or Indian medicine (Ayurveda) through literature review (Kyaw Soe & Tin Myo Ngwe 2004, Manandhar 2002, Na Ga Thain [publishing date unknown], Watanabe et al. 2005, Fujikawa et al. 2007). were also selected. And species promising Bioinformatics and Chemical Genomics were added on the list as having potential.

4) Selection and Preparation of Samples for Chemical Analysis

Species were selected from important genus listed in the Japanese Pharmacopoeia: JP15 (2006). All selected candidate species were tested for standard substance and compared to Japanese and Chinese herbal medicine. Samples collected in the field were sundried at the office of Natma Taung National Park and all were brought back to the lab and dried again at 35°C. Then, they were cut into small pieces and pulverized in a centrifugal separator as test samples.

5) Chemical Analysis

The quantitative method specified in the Japanese Pharmacopoeia: JP15 (2006) was applied. Thin-layer chromatography was used for validation tests, and for samples without specified quantitative methods, high performance chromatography for fractionation and quantification was conducted following methanol extraction. For details about chemical analysis, refer to Fujikawa et al. (2009).

Results

Economic plants in the Natma Taung National Park were summarized in the report “A Guide to the Economic Plants of Natma Taung, Natma Taung National Park, Myanmar”.

1) Flora Research

A total of three field works were carried out during the dry season between February and March, the beginning of the monsoon in May and monsoon period between July and August. Identification has not been completed yet for all samples, but it is being conducted by family. In regards to the Compositae

(Asteraceae) for which this author was responsible, it was reported so that one species of *Ligularia* was a new record for Myanmar (Fujikawa & Koyama 2008).

2) Species with Potential as Medicinal Resource

Species affirmed to be naturally growing in Natma Taung with potential as medicinal resource were selected and analyzed. Among them, four species: *Panax pseudoginseng* Wall. (Araliaceae); *Bupleurum candollei* Wall. ex DC. (Umbelliferae); *Gentiana sino-ornata* Balf. f. (Gentianaceae); and *Zingiber officinale* Roscoe (Zingiberaceae), listed in the Japanese Pharmacopeia: JP15 (2006) as belonging to a genus with many medicinal species, were selected as candidate species for chemical analysis. Details are described in the chemical analysis results. Here, habitat and morphological characters of species with potential medicinal resources excluding the four species above mentioned are described.

A: *Achyranthes bidentata* Blume [Amaranthaceae] (Fig. 4)

Achyranthes bidentata Blume belongs to Amaranthaceae, that is distributed throughout Asia and Africa, and *Achyranthes bidentata* var. *bidentata*, *Achyranthes bidentata* var. *faurieri* H. Lev. et Vaniot, and *Achyranthes japonica* Miq. var. *japonica* found in Japan. Its crude drug name is "achyranthes radix" and in Japan, the Chinese species *Achyranthes bidentata* Blume var. *bidentata* is imported and used as herbal medicine. In ancient Japanese herbal books, it is said to note that materials imported from the Tang Kingdom were preferable to those found in Japan.

Fig. 4. Rhizomes of *Achyranthes bidentata.*

In Natma Taung National Park, *Achyranthes bidentata* var. *bidentata* grows in elevations between 1,200 and 2,000 meters in areas with seeping water and along streams, or even cleared roadsides and shades at the forest edge. Rhizomes transverse and knots swell. The stems are 60 – 100 cm tall, stem nodes are swollen with sparse branches that spread horizontally. Leaves are oblong with acuminate apex and dark green. Inflorescences are found at the apex of the branch. Compared to *Achyranthes japonica*, the plant has more hairs.

Cyathula officinalis K. C. Kuan known as the "Sichuan achiranthis radix" can also be found in Natma Taung National Park. The species naturally grow and are cultivated in Sichuan, Yunnan, and Guizhou in China and its roots are used for the same medicinal purposes as achyranthis radix. Although it was once also imported to Japan from China, it is perceived to have no commercial value in Japan at present.

In Natma Taung National Park, plants of the *Achyranthes* and *Cyathula* species are not being used for medicinal purposes and no trade has been recorded in the Myanmar crude drugs market (Fujikawa et al. 2007).

B: *Zanthoxylum acanthopodium* DC. [Rutaceae] (Fig. 5)

This species can be found in the Himalayan mountain ranges and southwest of China. They grow along roadside or forest edges with plenty of sunlight in elevations between 1,800 and 2,700 meters in Natma Taung National Park. Small trees or shrubs, up to 5 m tall with thorns at stem nodes and branches. Branches have brown hair. The inflorescences are axillary with compound small flowers. Fruits are red and sometimes purplish red.

The pericarps of their fruits have smells and typical hotness. The smell is close to Sichuan Pepper "Huajiao" but has less hotness. It is not being used locally as medicine or spices. Young leaves are not being used for food either.

Fig. 5. Fruits of the *Zanthoxylum acanthopodium*.

C: *Asparagus filicinus* Buch.-Ham. ex D. Don [Liliaceae] (Fig. 6)

The species can be found in the Himalayan region and across China and Southeast Asia. In Natma Taung National Park, it was found in elevations between 1,600 and 2,000 meters at the edge of a secondary forest as well as pine forest. It is a perennial herb with well developed rhizomes, and climber.

The stem has no thorns. The leaf-like cladodes has 4 – 6 verticillation, is curved, and the lengths are not uniform. Monogenean flowers at the base of the cladodes are white and the fruits are orange and berries.

The species is used in China as a folk remedy (Chen et al. 1999), but there is no record of their use in Natma Taung. Plants in this family that are being used within Myanmar for medicinal purposes are the *Asparagus officinalis* L. These are cultivated and used for suppression of flatulence and digestive purposes (Kyaw Soe & Tin Myo Ngwe 2004).

Fig. 6. Rhizomes of *Asparagus filicinus*

D: *Paris polyphylla* Sm. var. *yunnnanensis* (Franch.) Hand.-Mazz. [Liliaceae] (Fig. 7)

"Rhizoma paridis", a Chinese crude drug being used as a herbal medicine in China is otherwise known as "Yunnan chonglu", the dried rhizomes of *Paris*. *Paris polyphylla* Sm. var. *chinensis* (Franch.) H. Hara and *P. polyphylla* Sm. var. *yunnanensis* (Franch.) Hand.-Mazz. The wild materials have been collected illegally and bought at a high price by Chinese buyers in Namta Taung National Park.

The species growing in Natma Taung National Park is *Paris polyphylla* var. *yunnanensis* and are found in evergreen forests at an elevation between 2,000 and 2,700 meters. Rhizomes develop well, stems erect, reach a height of up to 1 m, not branched, 6 to 8 leaves verticillate and the outer tepal is green. Terminal flowers bloom between April and June.

The species is a good source of cash income for the villagers. Without their cultivation, they become extinct from the forests as well. At Hilong village, pilot cultivation is being conducted as part of the JICA Partnership Program to cultivate this species for cash crops as well as conservation of the natural resources.

Fig. 7. Cultivation of *Paris polyphylla* var. *yunnanensis* (Hilong village).

3) Chemical Analysis

For details of results, see Fujikawa et al. (2009). The summary is presented here.

A: Myanmar ginseng, *Panax* cf. *pseudoginseng* Wall. [Araliaceae] (Fig. 8)

a. Habitat

Myanmar Ginseng grows on the forest floor of oak forest in elevations between 2,200 and 2,400 meters. Morphology of the underground portion consists of elongate rhizome with many nodes with a short inter-node. It has nodule-like node at the end of rhizome. Flowering season is between July and August, and flower to fruit ratio is very low. This species is illegally over-collected, and traded at a high price. Based on the information in 2008, it suggested that 1 viss (local unit, 1 viss = 1.6 kg) of raw material was worth around 200,000 Kyats (around 200 USD, according to project manager). Considering that the annual income of a park ranger of the Ministry of Forestry is about 400 USD, the trading rate is extremely high. If such illegal collection continues, the number of individuals decreases and extinction of the species will come into reality. Local people told us that they don't use this species as herbal medicine and that the buyer brings it out of Myanmar. In general the medicinal ginseng's additive value is high and abusive collection at its indigenous locality causes extinction, we launched the propagation project at Natma Taung National Park.

Fig. 8. Myanmar ginseng, *Panax pseudoginseng.*

b. Comparison of Morphological Characters

Myanmar ginseng, *Panax* cf. *pseudoginseng* is characterized by well-developed running rhizome with many nodes of short inter-node and by nodule at the end of the rhizome (Fig. 2B) . When compared with other species of genus *Panax* in Japan, Myanmar ginseng resembles *P. japonica* C. A. Mey

rather than *P. ginseng* C. A. Mey in their morphological characters. Myanmar ginseng clearly differs from Chinese *P. notoginseng* (Burk.) F. H. Chen and American ginseng, *P. quiquefolius* L. in the characteristics of swollen rhizome rather than elongated rhizome. Himalayan ginseng, *P. pseudoginseng* Wall. subsp. *himalaicus* H. Hara resembles Myanmar ginseng in having nodes and nodules at elongated rhizome, but differs from Himalayan ginseng in having many nodules even though Myanmar ginseng has only one nodule at the end of rhizome. As Watanabe (1999) shows that Himalayan ginseng is morphologically diverse, it should be noted that Myanmar species could be in the range of variation of Himalayan species. Comparison was also made with Vietnamese ginseng. According to the description by Zhu et al. (2003), although Myanmar ginseng has pale green disk, Vietnamese *P. vietnamensis* Ha & Grushv. var. *fuscidiscus* K. Komatsu, S. Zhu & S. Q. Cai has brown to deep brown disk. The species collected from Shan State in Eastern Myanmar was reported to be the same as *P. zingiberensis* C. Y. Wu et Feng from Yunnan Province in China (Tran et al. 2003). However, it was identified based only on their results of DNA level without comparison of morphological characters. Therefore, it was determined that the original descriptions of *P. zingiberensis* C. Y. Wu et Feng, as well as morphological comparison of characters, in addition to molecular phylogenetics that is proven to be effective in species determination (Zhu et al. 2003, Komatsu et al. 2004) was the next required step for species identification. Here, we will provisionally identify the specie as *Panax pseudoginseng* Wall. Our next challenges are to recognize the species by using all available methods.

c. Results of the Chemical Component Analysis

Observing the chromatogram of ginsenoside Rg1, Rb1, and chikusetsusaponin IV of Myanmar ginseng, *Panax pseudoginseng* and other "Panax" crude drugs that were collected from various areas using high performance liquid chromatography (hereafter HPLC), Myanmar ginseng exhibited a pattern that contains ginsenoside Rg1, Rb1, and chikusetsusaponin IV. This is the same pattern contained in Himalayan ginseng. Although these three compounds were observed, the quantity of the compounds was different, and Himalayan ginseng had an abundance of chikusetsusaponin IV while *Panax pseudoginseng* had several times the amount of ginsenoside in comparison to Panax ginseng. For results of the HPLC tests, refer to Fujikawa et al. (2009).

d. General Evaluation

Comparing Myanmar ginseng with other commercial ginsengs in market, Myanmar ginseng, *Panax pseudoginseng* has several times the amount of ginsenoside Rg1 and Rb1. Therefore it looks as though it is a high quality variation of "Ginseng", *Panax ginseng*. On the other hand, their component quantities are quite different from either *P. ginseng* or *P. japonicus*. It may suggest that Myanmar ginseng has possibilities as a new herbal medicine material rather than as an alternative to commercial ginseng circulating in Japan.

B: *Bupleurum candollei* Wall. ex DC. [Umbelliferae] (Fig. 9)

This species is commonly found in a wide range on the southern slopes of the Natma Taung National Park, along the mountain ridge in *Pinus kesiya* Royle ex Gordon forests or in oak forests at an elevation of between 2,000 and 2,600 meters. There is no record as medicinal use within Myanmar.

Fig. 9. *Bupleurum candollei.*

The morphological features of the root look similar to the crude drug Bupleuri radix, while the leaves are quite different from *Bupleurum stenophyllum* (Nakai) Kitag. in having oblong to widely oblong leaves. The rhizome has a slight bitterness like Bupleuri radix. The saikosaponin content has been confirmed to be about 2.6 %, higher than commercial Bupleuri radix (1.5 %) purchased in China.

In addition, one more species from the genus *Bupleurum* has also been found in this area. This is *Bupleurum longicaule* Wall ex DC. and morphological features are similar to *Bupleurum stenophyllum* and further comparison of external morphology and chemical analysis is needed. The plants grow in a limited area close to Hilong village in Mindat Township, at an elevation of about 1,600 meters, only in *Pinus kesiya* forests.

C: *Gentiana sino-ornata* Balf. f. [Gentianacae]

At Natma Taung (Mt. Victoria) peaks around 3,000 meters, the species were observed in grassy areas blooming around the dry season between December and March. There is no local medicinal use. The same species can be found in the southwestern region of China.

Morphological features of the rhizome are similar to the crude drug "gentianae scabrae radix" and have similar bitterness. The gentiopicroside content is 3.6 % almost similar to the Chinese variety (3.0 %), suggesting the possibility of its use as an alternative.

D: *Zingiber officinale* Roscoe [Zingiberaceae]

Materials being sold in a market at the center of the Kanpetlet were purchased. Although the channel of distribution was unknown, the species was cultivated domestically in Myanmar (Kress et al. 2003). From the field survey in Oak Pho village, the species was ingested as a remedy for fevers by crushing and adding hot water. Finger millet, *Eleusine coracana* is also being fermented to produce local wine known as Chin Beer, and ginger is added and ingested when locals develop a cough, adding to the record of the species being used for folk remedy in the area. It is also added to tea and ingested to warm the body.

The species has the typical hotness of medicinal "ginger" and the content of [6]-gingerol (6-G) was measured by HPLC and compared and a peak was recognized at the same position as the reference material 6-G. Also, in comparison to the 6-G content of 0.3 % in Chinese varieties, Myanmar varieties had 0.7 %, or more than twice the amount of [6]-gingerol. As it also has some hotness, therefore, there is some possibility for medicinal use.

4) Interview

The information on various species that we gathered from the ethno-botanical survey is given below for four species in details.

A: *Myrica esculenta* Buch.-Ham. ex D. Don [Myricaceae]

The species distributes over a wide range between Himalaya, China, and Southeast Asia. Evergreen trees grow up to 10 meters. Leaves are oblong or elliptical, with acuminate or rounded apex, acute base. It grows along forests and roads at elevations between 1,800 and 2,700 meters.

Ripe fruits are edible and it is eaten without being cooked. It is also used for firewood. Although there is no recorded medicinal use in Natma Taung, the bark is used for medicinal purpose (Na Ga Thain, publishing date unknown). In the Himalayas, the bark is used for medicinal purposes as well, branches for firewood, and fruits for food (Manandhar 2002).

B: *Litsea cubeba* (Lour.) Pers. [Lauraceae] (Fig. 10)

Litsea cubeba is a deciduous tree or small tree about 6 meters high. Leaves are lanceolate with acuminate apex, truncate base, serrate margin. Inflorescences are panicle with 5 to 10 yellowish flowers. The fruits are semi-spherical. It grows in sunny places at an elevation between 1,500 and 2,600 meters.

In Oak Pho village, it has been locally named as wild mountain pepper and the fruits are used for cooking as a spice. The essential oil that can be extracted from the fruit is used for aroma therapy in China. The branch is used as toothpicks and fruits are used for spice in Southeast Asia.

Fig. 10. *Litsea cubeba*. Planted around the village (or growing naturally).

C: *Docynia indica* (Wall.) Decne. [Rosaceae] (Fig. 11)

Deciduous trees, up to 8 meters tall with or without thorns on branches. Leaves are egg-shaped, elliptical, or lanceolate with rounded apex, rounded base and serrate margin. Leaf surfaces without hairs, dark-green on upper surface, and with dense hairs, white on lower surface. Flowers are white, fruits are yellow-green with spotted, and fragrant. It grows in secondary forests and planted as a hedge at an elevation of between 1,400 and 2,000 meters.

Wine is produced from the fruits and the plant used as a stock for apple trees. The species can be found in a wide range between Himalaya, China, and Southeast Asia. In Bhutan and the Sikkim region,

it is used for food or medicinal purposes (M. & R. C. Sundriyal 2003; Matsushima et al. 2009). In particular, in the Sikkim region their value has been assessed, and the cultivation has been promoted (M. & R. C. Sundriyal 2003).

D: *Prunus cerasoides* D. Don [Rosaceae] (Fig. 12)

The species are found throughout the range between Himalaya and China. Deciduous tree, 8 – 15 m tall, with egg-shaped, elliptical or lanceolate leaves with 2 to 4 stripes on petiole. Flowers are pale pink to dark scarlet and blooms in the autumn between November and December. Fruits are red turning black when ripe. It grows in secondary forests in Natma Taung at an elevation between 1,500 and 2,000 meters.

In Oak Pho village, the bark is used as a compress to treat swollen hands and feet. The soup after boiling the leaves and barks are also ingested during childbirth and postpartum. In Nepal, the seed oil is used to treat kidney and bladder stones, barks for swollen hand and feet, and twigs and leaves for miscarriages (Watanabe et al. 2005).

Fig. 11. *Docynia indica.* It is also used as a stock for apple trees.

Fig. 12. Bark is stripped from *Prunus cerasoides* to collect samples for chemical analysis.

Discussions

1) Species Diversity and Conservation

In Natma Taung National Park and its surrounding areas, it is reported that there are about 2,500 species of vascular plants (Mill 1995). It is thought to be because Natma Taung National Park is situated in the mid-west of Myanmar amongst the Chin Hills, lying beneath the third highest mountain in Myanmar, the Natma Taung (Mt. Victoria) of 3,053 m. The vegetation distribution pattern along altitudinal gradient is quite unique, as a wide vertical range allows tropical and subtropical plants to grow in lower areas and temperate plants to grow in higher areas. Different flora is observed in each altitudinal range, and making Natma Taung a virtual island and separating it from surrounding areas, which is thought to be giving rise to endemic species (Kingdon-Ward 1954, Tanaka 2005, Fujikawa et al. 2008). Natma Taung belongs to the Sino-Himalayan region, therefore, around the peak, *Rhododendron arboreum* Sm. (Ericaceae) and *Quercus semecarpifolia* Sm. (Fagaceae) are the dominant trees and in grasslands around the peak *Anemone obtusiloba* D. Don (Ranunculaceae) and other Himalayan plants can be found. Endemic species include *Potentilla montisvictoriae* H. Ikeda & H. Ohba (Rosaceae) and *Roscoea australis* Cowley (Zingiberaceae) that have been recorded only in Natma Taung National Park and Chin State which grow at an elevation between 2,600 and 3,000 meters.

Plants in temperate areas at high elevation in Natma Taung are close to species that are being used as crude drugs in Japan, such as *Panax pseudoginseng* that are closely related to *Panax ginseng* and *Bupuleurum* as well. Many such species with potential as medicine resources were observed. There were also the same species of crude drugs that are being used in China such as *Achyranthes bidentata* and *Paris polyphylla*.

The region and its forest, being rich in many medicinal resources, has already become a target as an illicit supply source. Villagers have collected medicinal plants with higher market value and buyers purchase them. Such illegal trade in the National Park, of course, is prohibited. If the plants are over-collected for short-term profit, it is highly possible that the local resources may exhaust in Natma Taung National Park and its surrounding areas as mentioned in the case of medicinal orchids. From interviews conducted by the rangers, two species, *Panax pseudoginseng* and *Paris polyphylla*, were found to be commonly traded medicinal plants. In regards to these two species, while it is important to prevent over-collecting through intensified patrols, it is also important to start propagation, as in the pilot cultivation of *Paris polyphylla* initated in Hilong village. Therefore, it would need to be supported by planning a technical cooperation project to follow-through until its sales. On the other hand, in order to preserve genetic resources, outside cultivation of its native area, i.e. national park office in Kanpetlet, Forest Department should also be considered. We are facing the risk that the species may be extinct in the near future, before we can find out an additional value of them.

2) Economic Plants Maintained through Shifting Cultivation

Secondary forests cover around Kanpetlet, which is thought to be the result of traditional shifting cultivation. Dominant trees are *Alnus nepalensis* D. Don and *Schima wallichii* Choisy and these are species whose seeds are carried by wind. *Alnus nepalensis* is cut down, left in the ground and set on fire, but it soon germinates from the stump and can grow very quickly. Felled trunks and branches are used for firewood. Also, some plants growing in these areas are used for folk remedies or other daily use such as the genus *Clematis* (Ranunculaceae) whose fruits are gathered and sniffed to cure sneezes, and a variety of poisonous *Milletia* (Leguminosae) is used for fishing by rubbing the surface and dripping its juices into the river to paralyze fish and catch them. Species such as *Bidens pilosa* L. that thrive in such areas and its variant *B. pilosa* L. var. *minor* (Blume) Sherff, alien species such as *Ageratum houstonianum* Mill., and common species such as *Artemisia indica* Willd. have been found to be used for folk remedies through interviews and ethnobotanical surveys. Among the mountainous areas in Laos, the cash income of local villagers is dependent on forest resources with economic value that can be found in secondary forests developed through shifting cultivation area (Yokoyama 2004). Plant diversity observed in secondary forests that have been preserved through traditional shifting cultivation plays an obviously important role in the livelihood of those living around Natma Taung National Park.

3) The Potential of Medicinal Resources and Inventory Research

In considering the use of plants for alternative crude drugs, validation tests were carried out in accordance with the determination method specified in the Japanese pharmacopoeia to make an overall assessment with scientific basis established through chemical analysis. Overall assessment has been made on four species and all samples exhibited potential as alternative crude drugs. Among them, *Panax pseudoginseng* had particularly high content of active compounds. The result suggested that it might become a new resource of crude drug.

It would be needed for more plant resources to be catalogued by field inventory. In addition, the knowledge based on scientific basis will be gathered in a sustainable manner so that the forest resources in the area surrounding Natma Taung National Park can be assessed. The inventory method for this process will require us through literary review and field surveys to distinguish economic plants and their related species, commit to collecting samples in the field, collect habitat information, identify species through specimen collection, and rapidly analyze samples for chemical analysis. Therefore, rangers will be trained with inventory skills along with coordination of basic and applied research at the Makino Botanical Garden.

4) Utilizing Forest Resources

Peoples who are living in this area are not aware or do not know yet that there are abundant natural resources in Natma Taung National Park. Non Timber Forest Products (NTFPs) have great potential as non-agricultural income sources, not only as medicinal resources, but also as food and spices. Current consumption is mostly for self-sustenance and the only varieties that are being traded as a regional, domestic, and international commodity is Wa-U (Myanmar Konjac) and a few others (See Chapter 4, Wa-U).

Bhutan, another mountainous country in Asia, protects natural resources and promotes sustainable utilization and management through forest policy and the Bhutanese Constitution (Tshering 2009). In Myanmar, it is hoped that similar provisions and management are implemented for the long-term sustainable use of forestry resources that are important to the livelihood of mountainous communities.

5) Regional Development and the Loss of Folk Remedy Knowledge

Information is limited but here we record the sense of "Loss of Traditional Culture" which was felt during the interviews for the villagers.

In the four villages situated near Kanpetlet, a survey was conducted regarding plants used for folk remedies and food, but less information could be gathered in the villages closer to Kanpetlet. In order of villages farthest from Kanpetlet, medicinal and food varieties identified were: Thalong Pan village, 31 + 31 species; Yelongpan village, 66 + 38 species; Oak Pho village 34 + 57; and Kanthar Yan village 9 + 30

species (medicinal + food varieties, respectively). Survey respondents from Kanthar Yan village, next to Kanpetlet, and Oak Pho village, only 30 minutes away on foot, said that when sick they go to hospital, whereas the farther two villages responded that pending on circumstances, they go to hospital or utilize medicinal plants when the symptoms are less severe. It is thought that the reason why much information regarding plant species was able to be collected in Oak Pho village close to Kanpetlet was because individual interviews were conducted with midwives. Each village always has a midwife and mothers do not go to hospitals except in the case of abnormal delivery so it is thought that they have specialized knowledge aside from the fact that they are elderly. Interviews were requested with midwives in other villages as well, but were declined. As interview formats varied by village, it is not possible to compare the collected quantitative data.

There is a hospital in Kanpetlet, but medicine is only available in town at the own, expense of patients. For villagers without cash income, it is difficult to acquire these, but effort is made to find cash to somehow purchase "medicine" that would definitively cure disease. In the past when there was no benefit of medical treatment, villagers relied on local sages and grandparents and elders to utilize medicinal plants around them to treat diseases, but there is a possibility that such knowledge would be lost in the present day. As mentioned previously, forest resource itself is declining, facing the risk that the traditional culture of folk remedies in the Natma Taung National Park area may be lost. It is true that medicines are still quite an expensive to purchase for villagers. If traditional knowledge of folk remedy is lost, at the same time, there might be a rise in the number of people who have no means of benefiting from either resource, in other words, people who have no means to treat their sickness. Therefore, there is a great need to catalogue traditional knowledge and the time has come for inventory research and assessment of the value of forest resources to be implemented.

Specific activities in the future will refer to demonstration methodology introduced by Yokoyama and Ochiai (2004): 1) Select villagers from around Kanpetlet with knowledge of traditional medicine and spend one day walking with each one of them to catalogue the plants found along the way determined to have medicinal, food, and folkloric purposes and record their name in Chin and Myanmar, note their usage and utilized parts, take specimens, and collect GPS data; 2) Take into account seasonal changes and conduct the same during both the dry and rainy seasons (if possible, divide dry warm and cold seasons); 3) Consolidate data and simultaneously validate the species of each specimen. It is thought that it is important to document first and preserve the knowledge maintained by the villagers.

References

Chen J., Su Y.-C., Chen G.-Q. and Wang W.-D. 1999. Ethnobotanical Studies on Wild Edible Fruits in Southern Yunnan: Folk Names; Nutritional Value and Uses. Economic Botany 53(1): 2–14.

Fujikawa, K., Htun Paw Oo, Aung Din, Kyaw Khaing & M. Okada. 2007. Botanical Inventory in Myanmar (1). Market Research of Herbal Medicine. J. Jpn. Bot. 82: 309–319. (in Japanese)

Fujikawa, K., A. Tsujii, T. Shimomoto, M. Okada & Shein Gai Ngai. 2009. A Botanical Inventory in Myanmar (2). Medicinal Plants in Natma Taung National Park. Chin State. J. Jpn. Bot. 84: 92–105. (in Japanese)

Fujikawa K., Kuroiwa N., Maeda A. Gale S., Shein Gay Ngai and Aung Din 2008. A Guide to the Forests of Natma Taung –Natma Taung National Park, Myanmar–. The Kochi Prefectural Makino Botanical Garden. pp. 30, Kochi Insatsu Co. Ltd., Kochi.

Fujikawa K., Kuroiwa N., Maeda A., Srisanga P., Shein and Gay Ngai 2008. Botanical Expedition to Natama Taung (Mt. Victoria) National Park, Chin State, West-central Myanmar in 2007. Newsletter of Himalayan Botany no. 41: 9–14.

Fujikawa K & Koyama H 2008. Ligularia japonica Less. (Asteraceae) new record from Myanmar. The Journal of Japanese Botany 83: 356–358

Kinlay Tshering 2009. Agriculture and Usage of Natural Resources in Bhutan. Journal of the Faculty of Agriculture Shinshu University 45: 33–42.

Komatsu K., Zhu S. and Sasaki Y. 2004. Systematic pharmacognostical study on Panax and Curcuma drugs: Phylogenetic analysis, molecular authentication and quality evaluation. Journal of Traditional Medicine 21: 251–270.

Kress W. J., DeFilipps R. A., Farr E. and Yin Yin Kyi 2003. A Checklist of the trees, shrubs, herbs and climbers of Myanmar. Contribution U. S. National Herb. 45: 1–590.

Kyaw Soe and Tin Myo Ngwe 2004. Medicinal Plants of Myanmar –Identification and Uses of Some 100 Commonly Used Species, series (1). Forest Resource Environment Development & Conservation Association (FREDA) pp. 255, Pyi Zone Publishing House, Yangon.

Mananhar N. P. 2002. Plants and People of Nepal. Timber Press, Inc., U.S.A.

Mill R. R. 1995. Regional Overview: Indian Subcontinent, pp 61-141. In: Davis S. D., Heywood V. H. & Hamilton A. C. (eds.) Centers of Plant Diversity: A Guide and Strategy for their Conservation vol. 2: Asia, Australia and the Pacific World Wide Fund for Nature (WWF) and The World Conservation Union (IUCN). IUCN Publications Unit Cambridge.

Na Ga Tain unknown. Medical Dictionary. 4-volumes. without publisher information (in Burmese).

Sundriyal M. and Sundriyal R. C. 2003. Underutilized edible plants of the Sikkim Himalaya: Need for domestication. Current Science 85: 731–736.

Tanaka N. 2005. Plant Inventory Research: Contributions to the Flora of Myanmar. Acta Phytotaxonomica et Geobotanica 56: 21–26.

Tran Q.-L., Myint Myint Than, Tezuka Y., Banskota A. H., Kouda K., Watanabe H., Zhu S., Komatus K., Maung Maung Thet, Thein Swe, Maruyama Y. and Kadota S. 2003. Wild Ginseng Grows in Myanmar. Chemical & Pharmaceutical Bulletin 51: 679–682.

Watanabe T., Rajbhandari K. R., Malla K. J. and Yahara S. 2005. A Hand Book of Medicinal Plants of Nepal. : 168. NPO Ayur Seed, Japan.

Zhu S., Fushimi H., Cai S.-Q., Chen H.-B. and Komatsu K. 2003. A new variety of the genus Panax from southern Yunnan, China and its nucleotide sequences of 18S ribosomal RNA gene and matK gene. Journal of Japanese Botany 78: 86–94.

2. Medicinal Orchids

Nobuyuki Tanaka

Myanmar is known as an area with very limited studies on the diversity of the family Orchidaceae within the Southeast Asian region. In the Natma Taung National Park and its surrounding areas, local villagers have been overcollecting orchids for export to China via land route through Shan State. It is said that the total amount of poached orchids across Myanmar amounts to ca. 1,000 tons per year. It has reached a critical state in which precious native orchid biodiversity within Natma Taung might be lost. It can be said that the project for developing human resources for protecting the biodiversity of orchid species in the world is the duty of the botanical garden and therefore one of its objectives.

In regards to activities related to medicinal orchids, cultivation for sustainable use of orchids is the main activity, but for cultivation, understanding the current status and biological information of medicinal orchids is indispensable. Therefore, to address the current issues: 1) Understanding the current status and scale of poaching; 2) Identifying species that are being overharvested; 3) Gathering necessary information including market research to prevent overharvesting; and 4) Research on the potential genetic resource of orchids in Natma Taung. At the moment, the villagers are collecting orchid species from the forests on Chinese buyers' request. However, there is a possibility that there are other orchid varieties within the Natma Taung National Park and surrounding areas, used for medicinal purposes in China. However, there is no inventory of Orchidaceae that grows in the area and so there is a need to search for and investigate Orchidaceae as potential genetic resources. Therefore, a research on the diversity of Orchidaceae was concurrently implemented.

Method

1) Specimen Collection Research

Two research expeditions were made from our base at the office of Ministry of Forestry in the Natma Taung National Park during the blooming period of epiphytic and terrestrial orchids from May 10 to 25 in 2007 and June 20 to July 4, 2009. The herbarium specimens and preserved specimens were collected in the field, of which one set each herbarium specimen was kept locally and an extra specimen and preserved specimens were sent to the Kochi Prefectural Makino Botanical Garden through the Nature and Wildlife Conservation Division of the Ministry of Forestry by applying to necessary procedures set forth by CITES. Based on locally collected data and specimens sent back, orchid species were taxonomically identified.

2) Market Research and Field Survey

Market research was conducted in markets in Kanptelet and Mindat. As there is a need to understand the diversity of local Orchidaceae, an inventory was made including all varieties such as ornamental orchids, grown in backyards, and sold in the market. Field survey was conducted through an orchid merchant living in Kanpetlet.

Results

Through the specimen collection, market research, and field survey, it was determined as a result of taxonomical analysis that there were currently 14 medicinal orchid species in Natma Taung. The local and scientific names of the 14 species are as shown on Table 1. Local names did not necessarily correspond 1-to-1 with the scientific names, but as a result of the research it was determined to have the distinction recorded in Table 1. Of these, *Dendrobium lituiflorum* Lindl. was recognized to be the species that the Chinese have started to purchase since 2008. The harvesting of this species

Fig. 1. *Dendrobium bellatulum* Rolf

had just started within the Natma Taung National Park and therefore has no local name. On the other hand, three species that grew in the wild in the Natma Taung National Park and surrounding areas were recognized to be medicinal orchids although locals had not known this. These three were *Dendrobium bellatulum* Rolf, *Dendrobium nobile* Lindl. and *Bullbophyllum proteranthum* Seidenf. *Dendrobium nobile* Lindl. is locally known as a crude drug source and relatively easy to cultivate and proliferate. *Dendrobium bellatulum* Rolf (Fig. 1) and *Bullbophyllum proteranthum* Seidenf. (Fig. 2) are also found in Chinese crude drug references and if their growth can be confirmed in Natma Taung, it is possible that orders for harvests will increase. For the cultivation of these species, it is necessary to begin consultation early and cultivation initiated at the head nursery.

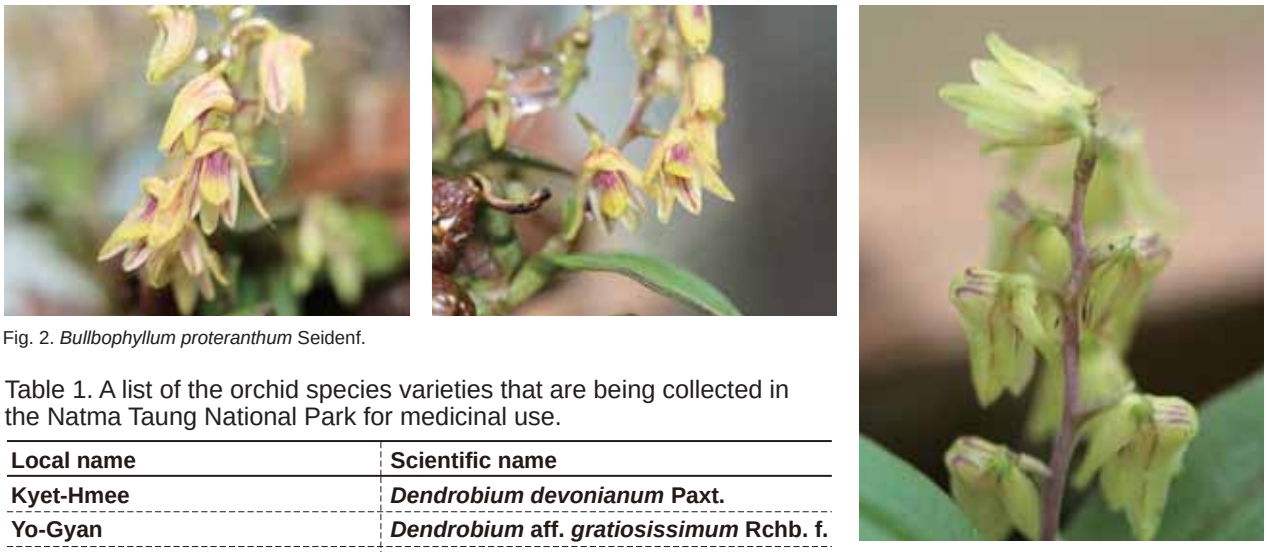

Fig. 2. *Bullbophyllum proteranthum* Seidenf.

Table 1. A list of the orchid species varieties that are being collected in the Natma Taung National Park for medicinal use.

Local name	Scientific name
Kyet-Hmee	***Dendrobium devonianum* Paxt.**
Yo-Gyan	***Dendrobium* aff. *gratiosissimum* Rchb. f.**
Yo-Gyan	***Dendrobium wardianum* Warner**
Yo-Gyan-Asit	***Dendrobium* aff. *bensonae* Rchb. f.**
Kha-Mauk-Kyoe	***Dendrobium cucullatum* R. Br.**
Yo-Shi-Atu	***Dendrobium cucullatum* R. Br.**
Nilon	***Dendrobium laterale* L. O. Williams**
Puzun	***Dendrobium denudans* D. Don**
Pale	***Dendrobium incurvum* Lindl.**
Pan-Myinn-Khwar (Thin-Kyu-Kyu)	***Dendrobium primulinum* Lindl.**
Pan-Myinn-Kyoe	***Dendrobium heterocarpum* Lindl.**
Kha-Yu-Shay	***Dendrobium* sp.**
Kha-Yu-Pu	***Dendrobium* sp.**
Ta-Pin-Shwe-Hti	***Nervilia aragoana* Gaudich.**
Ywet-Hla	***Anoectochilus* sp.**
	***Dendrobium lituiflorum* Lindl.**

The main medicinal orchid species and their general details are described below.

A. Kyet-Hmee

Kyet-Hmee is *Dendrobium devonianum* Paxt. (Fig. 3), but it is also known as Kha-Mauk-Kyoe. These local names are mainly used by villagers when collecting the varieties. When brokers actually trade them, they are referred to by code numbers. They are numbered 1K to 4K, for example. Through the field survey, we understood that 1K referred to *Dendrobium devonianum* Paxt. *Dendrobium devonianum* Paxt. prefers an environment with very good air flow.

Fig. 3. *Dendrobium devonianum* Paxt.

B. Yo-Gyan

The most complex variety is locally called "Yo-Gyan". Yo-Gyan was found to be related to *Dendrobium gratiosissimum* (Fig. 4). This plant was morphologically in-between *Dendrobium gratiosissimum* Rchb. f. and *Dendrobium wardianum* Warner. Also, it was found that there were actually three similar varieties known commonly as Yo-Gyan. The other two were a variety of *Dendrobium bensonae* Rchb. f. (Fig. 5) and *Dendrobium wardianum* Warner. These were found to be assigned codes 2K to 4K through the field survey. Yo-Gyan grows on the slopes of the Man and Woman hills to the west of Yelongpan village.

Fig. 4. Yo-Gyan. A variety of *Dendrobium gratiosissimum* Rchb. f.

Fig. 5. Yo-Gyan. A variety of *Dendrobium bensonae* Rchb. f.

C. Pan-Myinn-Khwar

Pan-Myinn-Khwar was identified as *Dendrobium primulinum* Lindl. (Fig. 6). This species can be found across India, Nepal, Himalayas, Myanmar, Thailand, Vietnam, and southern China. The flower is similar to that of *Dendrobium cucullatum* (syn. *D. aphyllum*) (Fig. 7), but it is different in that the labellum is a wide circular shape and rarely becomes cylindrical and only one flower blooms from each stalk. It is very easy to cultivate and proliferate with good rates of success but it has a lower market rate compared to other species.

Fig. 6. *Dendrobium primulinum* Lindl.

Fig. 7. *Dendrobium cucullatum* R. Br. (syn. *D. aphyllum*)

D. Ni-lone

Through detailed taxonomical analysis, it was identified as *Dendrobium laterale* L. O. Williams that was recorded in Chin State in 1941 in Dickason's collection (Fig. 8). This is unique and endemic to Myanmar. It grows in the northern part of the Natma Taung National Park at relatively high elevation with fog and high humidity. It was determined through this project that it dies after two years of cultivation.

Fig. 8. *Dendrobium laterale* L. O. Williams

Fig. 9. *Dendrobium incurvum* Lindl.

Fig. 10. One of the native species of medicinal orchids, *Anoechtochilus*. It is relatively easy to cultivate.

Through this project, it was determined that Pale was *Dendrobium incurvum* Lindl. (Fig. 9) and Puzun was *Dendrobium denudans* D. Don, but both are individually small species and seemingly difficult to cultivate a considerable amount.

Aside from these epiphytic *Dendrobium*, it was discovered in an investigation during the rainy season in June 2009 that there were three terrestrial species that were being smuggled to China. These were *Nervilia*, *Anoechtochilus* (Fig. 10), *Pleione*. Of these, the rhizomes of *Nervilia aragoana* Gaudich were collected by the local people of Natma Taung National Park for selling. (Fig. 11).

Fig. 11. One of the native species of medicinal orchids, *Nervilia aragoana* Gaudich.It can also be found in Okinawa in Japan.

Discussions

The plants similar to *Dendrobium gratiosissimum* were possibly natural hybrids of *Dendrobium gratiosissimum* and *Dendrobium wardianum*, but this could not be determined by the investigations thus far. With the current investigation, it was at least determined that *D. wardianum* was growing in the area. Therefore, it is possible that it is a natural hybrid. However, the other root species *D. gratiosissimum* has not yet been found to grow in the area so we would like to wait for results from further investigations.

In regards to the variety of medicinal orchids being purchased from Natma Taung, *Dendrobium lituiflorum* Lindl. was determined to have been purchased since 2008. If Chinese buyers recognize the existence of other varieties of medicinal orchids, it is possible that they will order their collectings. Also, it was discovered through the field survey that pending on the year there were species that were purchased and those that were not. This may relate to the demand in the market, but if certain species are continuously collected, there is a danger that they might be depleted so there is a chance that the purchasing schedule of certain species is being intentionally rotated.

Through the investigation conducted in this project, three species recorded in Chinese medical plant references were found to be growing in the area: *Dendrobium bellatulum* Rolf, *Dendrobium nobile* Lindl., and *Bullbophyllum proteranthum* Seidenf. It is thought that after the existence of these plants are recognized, there may be orders for harvests from the Chinese. Taking the above into account, there is a danger to simply select only 1 or 2 orchid species for cultivation. At least 3 to 4 species, starting with those easier to cultivate, should be prioritized and cultivated. It is probable that choosing species simply by market price would lead to an obvious failure.

The best condition for the cultivation for *Dendrobium devonianum* Paxt. must be further explored but it is most compatible to an area with strong winds and this must be taken into account for determining its cultivation environment.

For Yo-Gyan varieties, it is adequate to treat them as related varieties to *Dendrobium gratiosissimum*. As a result of this investigation *Dendrobium bensonae* and its related species can also be included. When observing Orchidaceae in Popa mountain or the Natma Taung National Park, there seems to be a greater diversification of *Dendrobium bensonae* species in Myanmar. A sample found in Popa mountain is also thought to be an unrecorded but related specie to *Dendrobium bensonae*. This group will require further studies. Yo-Gyan grows on slopes at around 1,400 m and prefers much sunlight, high temperature, and a slightly dry environment with wind flow during the dry season. This must be taken into account to create an environment for cultivation.

In regards to Ni-lone, it is not known if wild samples also die after two years. It could be that it originally has a short lifespan, but a determination of its characteristics is necessary. Therefore, areas of wild growth should be categorized and part of the sample should be transferred to a field to comparatively observe its condition after two years. If the cultivated sample dies and the wild variety is still alive, there would be an obvious proof that the cultivated sample had died due to cultivation. In this case, it must be determined whether the cause is climatic or related to fertilizers. Either way, there is a greater need to protect native Ni-lone species from overharvesting compared to other species.

In regards to medicinal orchids, the genus *Anoechtochilus* is relatively easy to proliferate and it is a variety for which cultivation is possible. In future project activity, there is a necessity to transfer cultivation methodology. However, other terrestrial orchids are expected to be more difficult to cultivate. Of the genus *Nervilia*, *Nervilia aragoana* is being collected and smuggled, but at least three species of genus *Nervilia* were discovered to grown in the Natma Taung National Park so there is a need to determine the rest of the locally available varieties.

What is necessary now in regards to medicinal orchids for this project is to reveal the diversity of Orchidaceae and determine which of these has potential medicinal qualities. For cultivation, support and assistance is necessary for continuing ranger training and followed-up so that orchid cultivation up to now can be further strengthened, and to proliferate appropriate species in appropriate environments.

3. Cultivation of Medicinal Orchids

Mitsuo Matumoto & Nobuyuki Tanaka

Many wild plants have traditionally been used for medicinal purposes in Myanmar. It is thought that collecting from forest was done within a permissible limit that allowed its sustainability. However, the plants are recently being traded in the international medicinal plants market (especially trade with China) and it is readily expected that collecting will exceed the propagation rate in the wild. Orchids with limited growth and reproduction speed are especially feared to be facing extinction. Among these are included unidentified and undescribed species, without scientific recognition, and endemic species to Myanmar and thus countermeasures are needed as soon as possible.

Therefore, we will seek to conserve local genetic resources of medicinal *Dendrobium* by cultivating it and promoting sustainable utilization as they are plants that are collected in great numebers from the wild. Here, we investigated cultivation methodologies for medicinal *Dendrobium* by means of axenic culture and rhizome section culture.

Materials and Methods

1) Sampling

Trial sample was collected in December 2008 at the head nursery (Orchid nursery set up in the Natma Taung National Park Office) and the mark proceeding K denotes the number assigned to each sample (Fig. 1). Also, the voucher specimens were prepared based on these numbers, for their rigorous identification, and deposited at the Kochi Prefectural Makino Botanical Garden Herbarium (MBK).

Fig. 1. Head nursery for medicinal orchids. Project manager being interviewed by a nation-wide TV station.

2) Micropropagation

Fruits of Yo-Gyan3 (*Dendrobium* aff. *gratiosissimum* Rchb. f.: Hilong materials, K923, K1233), Pan-Myinn-Kyoe (*D. heterocarpum* Lindl.: K513), and (Pan-Myinn-Khwar,Thin-Kyu-Kyu) (*D. primulinum* Lindl.: K425) were obtained from the head nursery or the Hilong nursery (orchid nursery set up in Hilong village) in December 2008 and their seeds were used to germinate on 26th December and 28th January. Yo-Gyan phylogeny, Pan-Myinn-Kyoe and Pan-Myinn-Khwar flowered in early January and late March and April respectively. The fruits were soaked in commercial detergent solution and then were surface-sterilized by immersion in 70 % ethanol for 30 seconds in a clean bench and later lightly burning the surface. The seeds were sown on MS medium containing 30 g/L of sucrose and 2 g/L gellan gum. The pH was adjusted to 5.7 before autoclaving. In the sowing conducted in January, Hyponex medium (Hyponex (6.5-6.0-19.0) with 30 g/L sucrose, 2 g/L gellan gum, pH5.7, was also set up as a reference.

3) Propagation by Cuttings

A second-year pseudobulbs of *D. devonianum* Paxt. (local name “Kyet-Hmee”) were used. The cuttings were prepared to cut 5 mm above each node of pseudobulbs. The cuttings were then planted to a rock wool cube (length 7.7 cm × width 7.4 cm × height 7.4 cm) with the node on the face of the cube. The cubes were managed under the shading net.

Results

1) Micropropagation

Three species and 5 individuals all germinated (Table 1). The density of seeds was very high. Germination was observed earlier from K513, K425=Hilong plants, K923=K1233 in respective order and K513 exhibited callus formations within 10 days of inoculation and protocorm formation was observed a month later. As of August 5th, K1233 had recorded the most growth, followed by Hilong, K923, K425 and K513. Yo-Gyan seeds germinated well in both MS and Hyponex medium. In the MS medium, germination was earlier than in the Hyponex medium and latter growth was also better. Perhaps because the seed density was too high, shoots stopped growing at about 1 – 2 cm and by August, shoots in the Hyponex medium grew light in color and browned in the MS medium.

2) Propagation by Cuttings

It was observed about half of the pseudobulbs developed adventitious shoots but all wilted during the cool dry season.

Table 1. Plant propagation of medicinal *Dendrobium* spp.

No.	Material No.	Local name	Germination and growing		
			Feb. 12	May 12	Aug. 5
1	Hilong	Yo Gyan	Protocorms with green spots	Many shoots in 10 mm long	Many great shoots in 2 - 3 cm long
2	K513	Pan Myint Kyaw	Shoots	Many great shoots in around 10 mm long	Many great shoots in 0.5 - 1 cm long
3	K425	Thin Kyu Kyu	Protocorms with green spots	Shoots in aound 3 mm long	Many great shoots in around 1 cm long
4	K923	Yo Gyan	Callus	A few shoots in around 3 mm long	Many great shoots in 2 - 3 cm long
5	K1233	Yo Gyan	Callus with green spots	Protocorms	Many great shoots in 2 - 4 cm long

Discussions

1) Micropropagation

To implement commercial cultivation for medicinal orchids, a large number of seedlings are needed to start. Therefore, three species that set fruits at the head nursery were tested for compatibility to micropropagation.

All tested seeds germinated very easily in MS medium. In regards to Hyponex medium, only *D. devonianum* was tested but germination was a little bit delayed and there was no problem for practical use. In areas where chemical reagents cannot be readily purchased, the Hyponex medium would be better. However, as incidences of adventitious buds formation did not vary much even among the *D. nobile* cultivars, response for *Dendrobium* varieties should be examined in advance.

Issues to be considered for investigation include appropriate sowing density, inter-row spacing, and acclimatization method.

Although commercial production of *D. devonianum* seedlings by micropropagation is already implemented within Myanmar, there is currently not much demand (Yasuda, September 28th, 2008 mission report).

2) Propagation by Cuttings

Fig. 2. A park ranger teaching villagers from Hilong village how to cultivate medicinal *Dendrobium* plants by cutting.

The micropropagation is one of the big factors raising production cost of orchids in Japan. Therefore, vegetative propagation methods that could be undertaken by cultivators themselves were investigated (Fig. 2).

One of the promising species, *Dendrobium devonianum*, is traded at Kyats 30,000/1.6kg or about USD 19 per kg and therefore it is a variety that would be most cultivated, and it was discovered that it can produce adventitious shoots with plant cuttings transplanted on rock wool mediums. However, this did not produce mature seedlings. This technique requires a basic facility for attentive care for watering and seedling maintenance, but there is already tea and coffee plantation in the locality so there should not be much problem. In regards to the latter, each home can set up a small enclosure for growing seedlings. Remaining issues are the efficiency and rate of propagation for each variety, the availability of material for plantation (various types of moss, coconut husks) and fertilizer.

3) Some Cases of Cultivation

Fig. 3. Medicinal orchids (*Dendrobium nobile*) being cultivated for commercial purposes in the outskirts of Yangon.

At the nursery, 30 cm long wooden poles (unknown wood type) were hung under cheesecloth and orchids were grown on them. However, in order to cultivate them as cash crops, a planting system with higher productivity must be introduced. The cultivation method of *Dendrobium nobile* at a field owned by the owner of a orchid (*Dendrobium*) café serving the *Dendrobium* tea, coffee and cakes in Yangon may be a good case (Fig. 3). Here, the round wooden poles are arranged in two tiers and orchids grown on both of them and therefore it seems applicable to home gardening scale as well. In the next project, we hope to introduce this method to the project sites and measure the productivity.

When cultivating with dead trees (branches), fertilizer becomes necessary because not enough nutrients can be acquired from the dead tree. At the head nursery, dried cow manure has been tested for its effectiveness since February 2009 but it has not been evaluated yet. In nearby areas, cooking oil was extracted from sunflower family, peanuts and sesame, and oil cake from this process could possibly be used.

Future Plans

Advice for varieties of choice and cultivation method is summarized here for JICA Partnership Program (Local government type) Phase II (To be initiated from January 2011).

1) Species for Cultivation

It is important to select varieties that are most appropriate for the cultivation area. In model villages, species can be chosen in discussion with park rangers, and Kyet-Hmee (*Dendrobium devonianum* Paxt.), Yo-Gyan (*D.* aff. *gratiosissimum* Rchb. f.), and Pan-Myinn-Khwar (*D. primulinum* Lindl.) are likely candidates. The reason is Kyet-Hmee has the highest local market price at 30,000 Kyats/1.6 kg (as of May 2007) and there is great local demand for cultivation. Yo-Gyan and Pan-Myinn-Khwar trading price is relatively low but trials at Yeolongpan and Hilong faced little trouble and were able to be reproduced through micropropagtion and therefore proposed as a candidate.

2) Technical Transfer

At the beginning of the project, among the target villagers in the model villages, an object of yield in three years, varieties of cultivation, cultivation methods (growth on wooden poles, trees, and wooden bed frame, etc.), amount of cultivation areas (calculated from target yield) and other detailed plans are to be decided through discussions between the National Park warden, park rangers, villagers, and MBK. In other words, the cooperative structure will be set so that securing profit from medicinal orchid cultivation and conserving forest resources become the issue of the local stakeholders. It is thought that by talking with the park rangers and villagers, especially the ranger and orchid specialist Mr. Hong Mang, skills that can be applied and shared and the project details will become evident. To this end and as a lesson from the previous project, there was mutual recognition that there was limited communication with the rangers and the villagers due to a lack of a Japanese speaking guide and this was an issue which the park manager and rangers especially requested to be addressed. Therefore, there is a need for a Japanese-Myanmar translator/ guide to accompany the project team to improve mutual understanding.

It is expected that a certain quantity of pseudobulbs of marketable size can be harvested through one year cultivation of one-year-old seedlings (supposing that a seedling with 5 cm stem length would be planted in May). The seedlings provided to villagers first will be produced in micropropagation, then acclimatized seedlings would be distributed to villagers by the park rangers (Participation in the project will be promoted by allowing villagers to experience cultivation skills and using seedlings that were produced by themselves). Further propagation by cutting will be done by each villager.

As such, the expected result of this project would be villagers capable of cultivating medicinal orchids in an implementable and sustainable manner, and even if small, a certain quantity would be available for harvest – in other words, the objective would be to achieve a result that suggests future directions.

4. Initiative for Cultivating Medicinal Orchids

Collection, Cultivation, and Propagation in Natma Taung

Yasuda Shigeo, Project Manager

The strategy for this project regarding medicinal orchids has been outlined in the project document submitted to JICA as follows:

Activity area and objectives

1) Activity area: Economic plants, cultivation of medicinal plants (orchid)

2) Activity objectives:

- Determining the number of orchids being illegally harvested from the forest and sold in black market for export;
- Attempting the cultivation and propagation of the selected medicinal orchid species;
- Exploring commercial models while determining the possibility of sustainable cultivation;
- Educating rangers about cultivation techniques; and
- Educating villagers about cultivation techniques through rangers.

Project Plan and Summary of Results

1) Project Details

A. Tabulation of Wild Medicinal Orchids in Natma Taung

The collected specimens were preserved in alcohol and were sent to Makino Botanical Garden along with photos and information for the process of species identification and tabulation. By including the market price of each specimen in Natma Taung and traded price at the trade center in Mandalay, it is hoped that species can be ranked in terms of priority for conservation. The table is presented separately in Chapter IV Part 2.

Fig. 1. Taking photos and preserving medicinal orchid specimens in liquid preservatives. January 20, 2008

B. Collection of Medicinal Orchids for Propagation

Rangers went around surrounding villages and collected specimens.

C. Construction of Propagation, Post-Planting Care, and Training Nurseries for Rangers

Three nurseries were constructed within the premises of Natma Taung National Park office.

At the end of the current project, up to 1,600 orchids were cultivated. Activities for propagation at these nurseries are detailed in later sections.

D. Nursery Construction for Orchid Cultivation in Three Model Villages

Two nurseries each were constructed in Oak Pho, Yelongpan, and Hilong villages. Medicinal orchids for test cultivation were gathered in each nursery and two villagers were selected from each village for daily care (including watering once every week during the dry season, monthly fertilization, and maintaining labels). Park warden designated rangers for the recruitment process by distributing fliers with the job content (day to day watering, fertilizing, etc.) to selected villagers and supervising its implementation.

E. Cultivating Medicinal Orchids in Forests near the Three Model Villages (Agroforestry)

Land was secured in the forests near Hilong and Yelongpan villages to implement agroforestry (details can be read in a separate section entitled "Project Activities"). Selection of the land was done in consultation with orchid cultivation specialists at the Queen Sirikit Botanic Garden (QSBG) in Chiang Mai, Thailand. Agroforestry was not implemented in Oak Pho village due to a lack of suitable forest area.

F. Cultivation Training of Rangers and Villagers by Specialists from Japan and Thailand

Several times every year, specialists from QSBG and Makino Botanical Garden visited to the project site to train and educate rangers and villagers.

Fig. 2. Mr. Mano Thamaragsa of QSBG leading a cultivation training session. May 17, 2007.

Fig. 3. Scene of a lecture to rangers. From the right, Dr. Tanaka, U Kyaw Khaing (translator), Dr. Santi Watthana and Mr. Mano Thamaragsa (both from QSBG). May 18, 2007.

Fig. 4. Cultivation training by Mr. Paisan Thongsorn (QSBG). Translation by U Kyaw Swar Lin. June28, 2007.

Fig. 5. Skills training by Mr. Paisan Thongsorn (QSBG) in the rain. June 28, 2007.

Fig. 6. Training of rangers for mass propagation of orchid by seed culture. Dr. Fujikawa (MBK). August 14, 2008.

Fig. 7. Lecture by Mr. Matsumoto. August 14, 2008.

Fig. 8. Visit to the Central Forestry Development Training Center (CFDTC), a training facility of the Forestry Ministry, with the rangers after concluding a seminar in Nay Pyi Taw. Tissue culture techniques were observed. May 8, 2009.

Fig. 9. Visit to CFDTC to observe tissue culture techniques. May 8, 2009.

Fig. 10. Rangers showing interest in displayed information about orchids. May 8, 2009.

G. Preparation of a Research Report on Possible Commercial Routes and Trade Partners in Yangon and Medicinal Orchid Trading Centers in Mandalay and Muse

Implemented in Mandalay in November 2007 (by Chief Researcher, Dr. Watanabe)

Fig. 11. A trade company in Mandalay with piles of medicinal orchids packed in jute bags for export. November 27, 2007.

Fig. 12. Dried medicinal orchids taken out of the bag.

Fig. 13. Two translators trying to gather information from the shop owner, Mandalay. November 27, 2007.

2) Results of Cultivation at the Nursery

Fig. 14. Preparation of logs collected from nearby villages by cutting them in equal lengths. July 19, 2007.

Between May and July 2007, medicinal orchids were cultivated at the head nursery and the nurseries in each of the three model villages. Firewood (species were not specified, but thick cork-like samples were chosen) was cut in uniform lengths of 30cm and orchid seedlings were tied on to these along with coconut fiber using bamboo strings. The direction was given by Mr. Mano Thamaragsa from QSBG. The structure of each nursery was also determined through his supervision. Coconut fiber was soaked were steeped in water for over a week and the water was exchanged every day. By doing thus, tannin is removed from the fiber. Such coconut fiber can be substituted with abundant moss in the mountains (advice from the Tropical Plant Resources Institute Inc. in Okinawa). For fertilizers, chemical fertilizer solutions that can be purchased in Yangon is most convenient, but if it difficult to purchase for villagers, it was recommended that they make balls of cow dung that can easily be acquired from Saw (also recommended by the above institution).

Hanging orchids from the thin wooden poles with wires is a good method for displaying many varieties, but it is too time consuming for commercial mass production of a single species.

In 2009, a test demonstration shelf was built to commercially produce many seedlings. With this shelf, it is easy to cultivate many seedlings. For future home gardening production, it is thought that this shelf is the best method.

Fig. 15. Soaking coconut fiber in water to drain it off tannin. July 19, 2007.

Fig. 16. The process takes one week. July 19, 2007.

Fig. 17. Moss that can be easily collected from the mountain roadside. It is ideal for planting orchids. Mr. Kamimura from the Tropical Plant Resources Institute Inc. in Okinawa. October 10, 2008.

Fig. 18. Mr. Kamimura advised that moss dangling from branches are good for use in cultivation. October 21, 2008.

Fig. 19. Planting by the rangers.

Fig. 20. Spraying for mold proofing. During the project implementation period, no molds developed. This chemical spraying may not be necessary for the project area. It may be necessary to receive expert input on this matter.

Fig. 21. Cow dung is prepared into balls and attached to the upper portion of each seedling.

Fig. 22. Cow dung is flattened and spread by hand. It will not fall off even when dry.

3) Initiatives for Propagation

Fig. 23. Under Mr. Matsumoto's direction, ranger trying artificial pollination. June 4, 2008.

For the commercial production of medicinal orchids, mass propagation and concentrated cultivation are needed. For propagation of orchid, seed culture is the common method, but to do this in Natma Taung area which lacks constant electricity supply is unrealistic and the climate is too cool for acclimatization (According to the opinion of the specialist from the Tropical Plant Resources Institute Inc. who visited the site, it depends on the variety of the orchid. For example, *Dendrobium devonianum* is not fit for acclimatization above temperatures of 30°C). In Natma Taung area, if the residents want to cultivate for the conservation of the species or for commercial means, the most realistic method would be to transplant cut stems.

There are too many pre-requisites, but if the electricity supply becomes stable and in an area at a lower elevation than Kanpetlet with a warm climate, a seed culture facility may be established if sustained maintenance can be carried out by acquiring capable human resources.

Fig. 24. Sample of Kyet-Hmee stalks transplanted on rock wool on May 24th of the same year. After two months, some of the samples were confirmed to grow roots. July 24, 2008.

Fig. 25. Close-up shot of the shoots. Aphids have attached themselves. July 24, 2008.

Fig. 26. Another close-up shot of the shoots. July 24, 2008.

Fig. 27. Kyet-Hmee shoots and roots that have grown. About half of the transplanted stems successfully germinated. October 11, 2008.

Fig. 28. U Hong Mang, a ranger training villagers for stem transplanting in Hilong village. August 5, 2008.

Fig. 29. Trial using mountain moss. August 5, 2008.

Fig. 30. Trialing a rooting experiment by placing cut stems on a bed of mountain moss (Yo Gyan). April 3, 2009.

Fig. 31. Trialing a rooting experiment by placing cut stems on a bed of mountain moss (Yo Shi Adhu). April 3, 2009.

Fig. 32. Demonstration shelf for mass cultivation (Yo Gyan). April 3, 2009.

Fig. 33. Ditto (Yo Shi Adhu). April 3, 2009.

4) Conclusion

It is thought that most of the initial objectives of this project were achieved within the two years. However, although this project had the objective of orchid propagation, cultivation, and sales in Natma Taung area, it began with a little feasibility study so much of the work on the ground was implemented on a trial basis, resulting in the opinions of many people being thrown around and this was a very big mistake that we must learn from.

Under such circumstances, 70 species of wild orchid species (40 epiphytic and 30 terrestrial) were collected for the head nursery. Also, the wild orchid flower samples preserved in an ethanol solution and specimens were sent to the herbarium at the Makino Botanical Garden (MBK). 240 such specimens (for most specimens, six duplicate specimens were produced) were arranged to be sent. Although it took a lot of effort to produce with the rangers and it was very time consuming, it is hoped that the results will come to fruition and feed back to the project.

Most orchids collected from the mountain for medicinal purposes, the species have been determined and tabulated. This will be an important reference to form the basis of future conservation efforts. It is hoped that proceeding projects will further improve the detail of this database.

On the other hand, it was not possible to achieve commercial production of medicinal orchids or create a cash income for the villagers within this project period. This was, as mentioned before, inevitable, having started the project without an adequate feasibility study. It is said that there is no control at the borders for illegally traded dried medicinal orchids being exported to China via Mandalay and Muse. Also, control by the Forest Department and National Park office against illegal collecting within the Natma Taung area is very much lacking in enforcement. This is in a sense a natural outcome of having to manage a vast land area of 722.6 km^2 with only 10 poorly equipped rangers. Therefore, it is impossible to regulate at the areas of collect and even at customs, leading to a free-for-all in collecting from the forests and subsequent export. As a result, cultivated orchids that have a higher cost of production cannot survive a price competition and cannot be sustained as a business. This was reported directly from a cultivation supervisor from the Myanmar Agricultural Service [MAS] (the commercial arm of the Ministry of Agriculture and Irrigation) at Pyin Oo Lwin.

To get out of such a situation, poachers must be punished and border control must be strengthened. The former can be implemented to a certain degree after the Natma Taung area's notification for national park status is completed, but the latter involves a large financial transaction so it is probably impossible to realize without a fundamental reorganization.

In future projects, it is recommend that while efforts to find sales routes for cultivated species should be sustained, the focus should be shifted towards species conservation.

5. The Adaptability of *Coix lacryma-jobi* var. *ma-yuen* and *Cassia obtusifolia*

Mitsuo Matsumoto

The objectives of the project are to conserve forest resources and improve the livelihood of locals by protecting medicinal plants that face extinction due to over-collecting, by means of sustainable production as cash crops. This project focuses on the cultivation and commercial production of medicinal orchids, *Dendrobium* genus that are in immediate need of conservation. However, there were still unknown factors regarding the cultivation of medicinal orchids and it is further expected that it would take several years until commercial production.

Therefore, until the commercial production and sales of medicinal orchids is realized, other medicinal plants that could yield annual cash revenue were also introduced. *Coix lacryma-jobi* var. *ma-yuen* (adlay) and *Cassia obtusifolia* (sicklepod) were trialed and assessed on their adaptability.

These plants were chosen as they have a steady demand in Japan for crude drug use and cultivation is easy, and additionally residual foliage can also be used for high-quality cattle feed (adlay) or fuel (sicklepod) and can be utilized for local livelihood. Furthermore, there is a report of adlay being introduced to mountainous areas in Laos as a cash crop with less labor-intensity, requiring less weeding, compared to a local rice variety grown on upland fields. It has been exported to Thailand with initial harvests 3 to 4 times that of the rice variety with market prices 8 times that of unhulled rice (Yokoyama 2005).

Materials and Methods

1) Plant Materials

Local adlay and sicklepod cultivars donated from the Tokyo Metropolitan Physic Garden were used.

2) Field Conditions

Both crops were grown in three fields (Table 1) with different elevations in Oak Pho (Fig. 1), Village-gate and Lower Land (Fig. 2). Soil conditions at each field were as shown in the chapter on production conditions.

3) Cultural Practices

The methods of planting, sowing dates, planting dates, and plant densities are shown in Table 2. The main fertilizer was dried cow dung, of which 250 kg/10a was applied to the Oak Pho field, 400 kg/10a at the Village-gate field, and 500 kg/10a at the sicklepod field in Lower Land.

Fig. 1. Adlay (ridges on either side) and sicklepod (middle ridge) at the Oak Pho field.

Fig. 2. Growing adlay plants. Growth rate was much better in areas rich in fertilizing ash (Lower Land field).

Table 1. Outline of trial fields

Field	Area(㎡)	Altitude(m)	Direction of slope	Terracing	Soil texture	Preceding crops
Oak Pho	4,200	1,750	SSW	Terracing	CL	Grass land
Village-gate	2,400	1,200	NNE	Terracing	L	Adlay/Grass
Lower Land：sicklepod	550	1,100	SSE	-[Z]	L	Vegetables
Lower Land：adlay	1,430	1,050	SE	-	L	No（first cropping）

[Z] Land reclamation in natural slope

Table 2. Cultural conditions of field trials

Field	Crop	Planting[Z]	Sowing (Month/Day)	Setting (M./D.)	Row width × Interrow space × Plant spacing(cm)
Oak Pho	Adlay	Direct sowing	5/5		100×40×20
		Transplanting	2/22	4/30	
	Sicklepod	Direct sowing	5/5		
Village-gate[Y]	Adlay	Direct sowing	5/8・5/21		100×40×20
	Sicklepod	Direct sowing	5/5・5/22		
		Transplanting	3/8	5/15	
Lower Land[Y]	Adlay	Direct sowing	5/5		60×－×20
		Transplanting	5/5	6/6	
	Sicklepod	Direct sowing	5/8		100×50×20
		Transplanting	3/8	5/9	

[Z] Adlay and sicklepod plants were planted on one after another ridge in the Oak Pho field and the Village-gate field. In the Lower Land, they were planted on the different fields respectively.

[Y] Adlay plants both in the Village-gate field and the Lower Land's were applied 200 kg・field^{-1} of chicken dropping.

4) Growth Measurement and Yield Survey

The growth investigation of adlay and sicklepod were conducted on the 7th of August, 2008 at the Oak Pho field and at Village-gate and Lower Land fields on the 8th. For adlay, growth grades were estimated by 3 grades of “good” (the standard yield in Japan, 300 kg/10a was expected), “moderate” and “poor”, and plant length, number of stems and number of bracts were measured. Ratios of each grade for the field were visually rated. For sicklepod, growth was rated according to three grades depending on the height of the plant as good (height of around 70 cm), medium (about 50 cm), and poor (less than 40 cm) and each grade plants were again assessed for their plant height and the number of flowers (flowers + fruits) by plant groups (row width x 2 meters). A field assessment of growth rate was visually evaluated.

Ripe fruits were continuously harvested and weighed on December 4th after the end of harvest.

Results

1) Growth of Adlay

In August, 30 % of Oak Pho field was covered with weed and field management was insufficient. Transplanted plants were ripening and their growth grades were assessed as moderate and relatively uniform. Most direct-sown plants were in the flowering stage and their growth grades were assessed to be

rather good to poor with largely varying uniformity.

The Village-gate field was relatively well managed. The growth of adlay markedly varied in individual plants. Plants at the plot which was a mature field near home grew very well. Plants at the prior slash-and-burn plot showed poor growth. For such area, only 1 to 2 plants per a planting site have grown by the end of May and their plant length was short and a few in tiller. Their growth stage was varied from a seedling stage to a flowering stage in which plants had grown up to 1 m.

The Lower Land field was weeded and managed very well. Transplanted plants were growing with relative uniformity and were in the flowering and fruiting stage. Direct-sown plants had varied from the vegetative stage to the flowering stage and their leaves were light in color and showed a symptom of nitrogen deficiency. The leaf color improved somewhat by applying chicken manure as fertilizers.

2) Prediction of Adlay Yield

Based on the result of growth investigation, the crop index as of early August was the following (Base index 1 set at 300 kg/10a, as determined by the Agriculture, Forestry and Fisheries Technical Information Society 2009 to be the expected yield in Japan): Oak Pho, 0.4-0.5; Village-gate, 0.3-0.5; Lower Land, 0.6. An overall yield will depend on climatic conditions and effectiveness of additional fertilizer, but it is expected to be about 60 % of the target yield.

3) Adlay Yield

Yields at the Village-gate field and the Lower Land field averaged 120 kg/10a, or about 1/3 of the expectation. The yield at the Oak Pho field was a further half of that amount.

4) Growth of Sicklepod and Yield Prediction

Growth of sicklepod plants mostly was very poor at the Oak Pho field. At the Village-gate field, it was not uniform at all. Transplanted crops reached maturity without securing enough growth. Fruits were harvested as they became ripe. At the Lower Land field, growth of plants on a ridge near the forest was poor but overall growth was good. Transplanted plants were short in plant length but in the mature stage, and fruits were harvested when ripe.

From the growth grades as of August, it is predicted that yield at each trial field will be, in comparison to the average of 200 kg/10a (Fujita 1970) in Japan, a little less than 40 % in Oak Pho and Village-gate, and about 70 % in Lower Land.

5) Sicklepod Yield

The yield per 10a was greatest in Lower Land at about 146 kg, Village-gate about half that at 73 kg, and Oak Pho less than 1 kg (Fig. 3, 4).

Fig. 3. Preparation of harvested adlay.

Fig. 4. Total harvest of sicklepod from a 2,000㎡ field in Oak Pho.

Table 3. Results of growth investigation of adlay plants

Field	Planting	Growth	Number of seedlings per hole	Number of stems per hole	Plant length (cm)	Number of bracts
Oak Pho	Direct sowing	good	1.0	5.2	124	23.7
	Direct sowing	moderate	1.1	5.7	119	25.5
	Direct sowing	moderate	1.0	5.8	99	9.4
	Direct sowing	poor	1.0	3.5	77	4.3
	Direct sowing	poor	1.1	3.2	58	2.7
	Transplanting		1.4	8.5	111	110.7
Village-gate	Direct sowing	good	1.9	10.9	169	207.8
	Direct sowing	moderate	1.7	5.1	109	34.0
	Direct sowing	moderate	1.3	4.8	135	50.5
	Direct sowing	poor	2.0	3.9	55	2.1
	Direct sowing	poor	1.5	4.3	68	2.7
Lower Land	Direct sowing	moderate	1.3	3.3	102	20.0
	Direct sowing	moderate	1.0	3.6	107	3.6
	Direct sowing	poor	1.2	3.4	41	4.0
	Transplanting		1.7	2.3	127	34.0

Table 4. Area percentage of growth grade of adlay plants

Field	Site	Growth grade		
		Good	Moderate	Poor
Oak Pho	west	5	85	10
	middle	5	70	25
	east	0	50	50
Village-gate	south	15	65	20
	middle	5	75	20
	north	0	5	95
Lower Land	west	5	85	10
	east	0	90	10

Table 5. Results of growth investigation of sicklepod plants[z]

Field	Planting	Growth	Number of plant/hole	Plant length (cm)	(Fl+Fr)[Y]
Oak Pho	Direct sowing	moderate	1.6	25	1.4
	Direct sowing	poor	1.9	10	0.3
Village-gate	Direct sowing	good	1.8	64	24.6
	Direct sowing	moderate	1.4	39	17.2
	Direct sowing	moderate	1.6	53	25.7
	Direct sowing	poor	1.5	17	4.8
	Transplanting	moderate	1.6	46	56.5
Lower Land	Direct sowing	good	1.4	72	43.3
	Direct sowing	good	1.3	82	64.6
	Direct sowing	moderate	1.3	48	28.7
	Transplanting	poor	1.3	37	24.0

[Z] Investigating date: 2008, Aug. 7 - Aug. 8.

[Y] Number of flowers and fruits per a plant.

Table 6. Area percentage of growth grade of sicklepod plants

Field	Site	Growth grades		
		Good	Moderate	Poor
Oak Pho	west	0	40	60
	middle	0	60	40
	east 1	10	50	40
	east 2	0	50	50
Village-gate	south	10	45	45
	middle	5	60	35
	north	0	10	90
Lower Land	whole	70	25	5

Table 7. Yields of sicklepod and adlay at the field trials

Field	Sicklepod		Adlay	
	Area (a)	Yield (kg)	Area (a)	Yield (kg)
Oak Pho	21	125	21	0
Village-gate	12	152	12	88
Lower Land	14	155	5	73
Total	47	432	38	161

Discussions

1) Adlay

For the production of adlay, greater number of flowers must be secured by strong early growth, and cultivation management is needed to increase the maturity of fruits after flowering (Ishida 1981). For this, high soil fertility or appropriate nitrogen fertilization is required. The growth investigation conducted in August showed that depending on fields and also locations within the field, there is great growth inconsistency from those that stop growing as seedlings to others that grow well and approaching maturity with flowers and formation of fruits. Leaf color of plants was light, suggesting nitrogen deficiency. Dried chicken manure was applied as additional fertilizer, but at the time of harvest there were many immature or abortive fruits and the effect of additional fertilizer was not sufficient. Presumably, this would be the reason why the harvest at Oak Pho and Lower Land was lower than predicted in August.

It is assumed that the main reason for low yields was low soil fertility of trial fields. Furthermore, the low yield at the Oak Pho field would have been caused by low temperature and sunlight during the rainy period. The success of introducing adlay to the Natma Taung area will depend on improving soil fertility by applying fertilizer and organic materials and maintaining the stability of the fields. It was also determined that high elevation sites like Oak Pho were not adaptable to plantation.

2) Sicklepod

Although a sicklepod is Leguminosae, root nodules do not form and drains fertility from the soil (Fujita 1970) and its growth depends on the fertility of the field, therefore resulting in great growth inconsistency like adlay.

The yields at the Village-gate field and the Lower Land field were almost as predicted in August. The yield seemed to exhibit strong climatic influence, and was relatively good at the Lower Land field (at an elevation below 1,000 meters) which is warmer with less rain than Oak Pho. The growth of sicklepod was very poor at the Oak Pho field, which lacked sufficient sunlight and warmth due to high elevation, daily fog and rain.

While sicklepod have no serious pests or disease and is easy to cultivate, it requires warm temperature and plenty of sunlight. So, a front survey on local climate must be done prior to its introduction. Lower

Land would be adaptable to sicklepod cultivation, because sicklepod harvested about 70 % of the average Japanese yield in that field where soil fertility was low. Oak Pho was estimated to be inappropriate for introducing sicklepod that prefer sunlight and warm condition.

In regard to the planting method, transplanting did not result in sufficient growth and therefore proven to be not adaptable.

Issues to Solve and Countermeasures

1) Adlay

Maintaining the Soil Fertility
Utilizing organic fertilizer such as cattle dung will be recommended, but the current situation will not allow us to secure sufficient quantities from within the area. Each household will need to make barnyard manure with the drylot feeding of chicken and pigs. Otherwise, mixed cropping with leguminous plants and alley cropping utilizing legumes may be a solution. In this case, selection of appropriate species of plants and trees will be an issue.

Selection of Adaptable Varieties and Crop Systems
Local adlay varieties have higher grass and more tillers than the variety that was used for the field trial and had obviously different plant type and growth. A forced cultivation with transplanting seemed promising for increasing yield, but this resulted in reaching harvest period during the rainy season and therefore it may be difficult to store a harvest. Varieties that are most adaptable with the high altitude humid tropics of Natma Taung must be selected, along with appropriate crop systems.

Coix Seed Processing
It is better for adlay to be sold after being processed into more marketable coix seeds. The processing equipment such as a husking machine and a rice polisher could be obtained at nearby paddies for grain husking and coix seed processing should be considered.

Securing a Distribution and Sales System
A stable sales route must be secured, as well as building a system for the storage and distribution of the harvest. At this time, harvested fruits were gathered in fishnet bags and stored in a room with good ventilation, but appropriate storage may be difficult if harvesting occurs during the rainy season.

2) Sicklepod

Selecting Appropriate Farmland
As it is a plant requiring plenty of sunlight and warm temperature, climatic conditions must be researched and assessed prior to its introduction. *Cassia* sp. naturally grows in the lowlands close to the town of Saw, so areas such as these would be promising.

Securing a Distribution and Sales System
As it is easy to cultivate, it is plausible that there will be demand to plant them in optimal areas such as Lower Land. In order to respond to such demand, a stable sales route must be secured.

Maintaining Soil Fertility
Fertile soil is best, and collaboration with an animal industry and other means of supplying sufficient fertilizer would be necessary.

References

Ishida, K. 1981. The adlay. pp. 32-41 (in Japanese). Rural Culture Association Japan. Tokyo.
Fujita, H. 1970. The cultivation of new medicinal plants. pp. 57-60 (in Japanese). Hirokawa Book Store, Tokyo.
Yokoyama, S. 2005. Shifting cultivation. Science Journal KAGAKU 75: 450-454 (in Japanese).
Japan Association for Techno-innovation in Agriculture, Forestry and Fishers. 2009. http://www.afftis.or.jp/

6. “Wa-U” (Myanmar Konjac)

Mitsuo Matumoto & Nobuyuki Tanaka

There are several species of konjac (*Amorphophallus* spp.) that are distributed in the wild in Myanmar, and of these, the species with mannan content is called “Wa-U” and the one with the least “Wa-Boat”, distinguishing the two. In the Shan State area bordering China, Wa-U is processed into konjac and consumed, but in limited quantity (Than Sein 2003). Wild Wa-U has been exported to Japan, and recently due to increased exports to China, it has come to be cultivated as a crop (Japan Konjac Association, 2007). In the Natma Taung area, new cultivators have started to cultivate Wa-U in a large area (Fig. 1). However, for most people Wa-U is usually collected from the forests and therefore there is an increased risk of extinction through over-collecting. In order to conserve such as valuable forest resources, a way for sustainable production needs to be developed quickly.

In Japan, konjac is a product of mountainous areas. In Myanmar, Wa-U seems to grow well in mountainous areas and it is said that Wa-U production in flatlands around Yangon is hardly sustained due to serious diseases. Such valuable mountainous crops will assist regional development in the mountainous regions like Natma Taung, so it should be promoted.

In order to convince the villagers of the merit to cultivate Wa-U rather than to collect it from the forest, technology transfer for cultivation, proliferation through seeds and bulbils, and processing (dried tuber slice) will be attempted through the guidance of the park rangers.

Fig. 1. Wa-U field in the outskirts of Kanpetlet.

Methods

1) Seminar and Workshops

Seminars and workshops about Wa-U were organized as follows:
A: May 23, 2008 “Field Trials for Economic Plant Introduction and Promotion in Mountainous Areas: Adlay, Sicklepod and Wa-U”; B: December 5, 2008 “Cultivation of Konjac in Japan” – The workshops were conducted for all park rangers in the Natma Taung National Park; and C: February 24, 2009 – Further workshops in Kanpetlet and in Mindat on the 26th targeting villagers to promote natural konjac seedling cultivation method (Fig. 2).

2) Growing and Yield Investigation

In regards to the growing and plant characteristics, the growing status was investigated in: A) May 2008 at Oak Pho and Yeolongpan and B) August 2008 at Oak Pho, Yeolongpan, and Hilong, with additional plant characteristics analysis at Oak Pho for representative samples. C) The yield surveys were conducted at the Oak Pho and Hilong field in December 2008. Characteristics of tubers of two cultivars acquired in Mindat, one yellow and another red, were surveyed in accordance with guidelines set forth by the Species Registration Characteristics Examination Standard of the Japanese Ministry of Agriculture, Forestry, and Fisheries (MAFF). Total yield was weighed by dividing tubers over and under 300 g. Tubers over 300 g were sliced and dried for sale.

3) Status of Cultivation

Field survey was conducted at backyards of homes or home gardens in Kanpetlet, Yeolongpan, and Mindat, as well as a large-scale plantation in Kapnetlet.

4) Technique Guidance

Training targeting park rangers was conducted in: A) May 2008; B) August 2008; and C) March 2009, during missions to the Natma Taung area, based on the konjac cultivation method in Japan to give guidance for planting tubers, setting up green mulch, slice drying, and other techniques for Wa-U cultivation.

5) Identifying Wild and Cultivated *Amorphophallus* in Natma Taung

Specimens were made from a sample and a tuber of *Amorphophallus* in vegetative stage under cultivation and during the flowering period. The specimens were deposited in the Kochi Prefectural Makino Botanical Garden Herbarium (MBK).

Results

1) Seminar and Workshops

Fig. 2. The very vibrant Wa-U seminar venue (Mindat).

A: At the workshop "Field Trials for Economic Plant Introduction and Promotion in Mountainous Areas; Adlay, Sicklepod and Wa-U", Japanese konjac cultivation method and countermeasures against disease, pests, and replant failure was explained. There were a lot of questions regarding cross-breeding and seed collection of Wa-U. Villagers had a deep interest in Wa-U cultivation.

B: At the workshop "Cultivation of Konjac in Japan", the phenology of konjac, cross-breeding and seed collection method, and basic cultivation management work (planting, weeding, green mulch, and harvesting) were explained.

C: At Kanpetlet and Mindat workshop venues, 144 and 128 villagers, respectively, participated. The natural seedling cultivation of Wa-U (Two- to three- year tubers which have grown from naturally dropped bulbils were collected. Applying green mulch and manure fertilizer is almost all the maintenance needed.) was recommended in the lecture, as it would require no special technique. It was suitable for home gardening with fruit trees, but not for mechanization as the intensive cultivation in Japan. The importance of green mulch for Wa-U cultivation was stressed. Producing fertilizer from the excreta of pigs that are commonly raised in the area was also promoted.

There were questions regarding the use of konjac in Japan, planting method, vegetative propagation method, optimal farmland, harvesting period, and Wa-U varieties (Fig. 2).

2) Growth and Yield Investigation

A: May 2008, Wa-U plants were in the flowering stage and no leaf growth was observed. In both fields, one year tubers that were originally collected from the forest were planted, but many plants with flower stem growing were observed (Fig. 3). There were different species among Wa-U plants cultivated in the field, which had small tubers, enlarged, not edible tubers with bad quality (Fig. 4).

B: August 2008: At the Oak Pho and Hilong fields, leaves had developed and new tubers were in the growing stage. In both fields, individual diversity in petiole color

Fig. 3. Flower of "Wa-U" (*Amorphophallus bulbifer* Blume).

Fig. 4. *Amorphophallus napalensis* (Wall.) Bogner & S. J. Mayo that appeared in a Wa-U field.

and petiole mottles and leaflet shape was observed. Locally, red, yellow, and white varieties were being distinguished (Fig. 5).

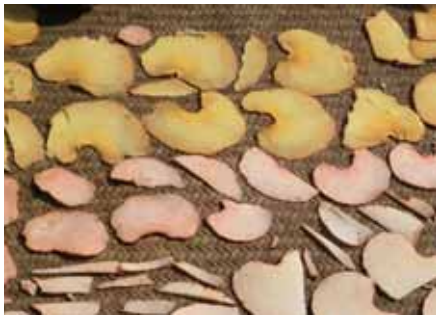

Fig. 5: Making dried slices of Wa-U. Two varieties, yellow and red can be observed.

C: December 2008: The yield of tubers over 300 g each in the Oak Pho and Hilong fields were 272.5 kg and 58.5 kg respectively (Table 1). The yield per the number of planted seed tubers was 53 % in the Hilong field and was unmeasured in the Oak Pho. In both fields, there were two types of tubers: one had dark brown skin and salmon-pink inside, the other had yellow-brown skin and light yellow inside (Table 2). Bulbils planted in the Hilong fields did not grow enough due to disturbance of weed. Total yield of bulbils in the Oak Pho fields was 9 kg and 3 kg in the Hilong fields. Some bulbils were large with a diameter of 3 cm but most were smaller with 1-2 cm diameter.

Table 1.Results of harvest investigation at the field trials

Field	Total yields of tubers (kg)	More than 300g tubers		Bulbils (kg)
		Number	Weight (kg)	
Oak Pho	518	–[Y]	272.5	9
Yeolongpan[Z]	0	0	0	0
Hilong	–[Y]	111	58.5	3

[Z] All Wa-u plants were damaged by pigs pastured.

[Y] Not investigated.

Table 2.Characteristics of tubers

Items	Strain	
	Yellow	Red
Shape	slightly flattened ～ globular	slightly flattened
Number of tuber wrinkle	few	medium
Skin color	light browm	dark brown
Flesh color	light yellow	light pink
Fresh weight (g)	530	500
Dry matter persentage	22.4	20.0
Distribution of sucker scars	dispersed	concentrated
Process of sucker scars	absent	present
Degree of bud hollow	slightly deep	slightly deep

3) Cultivation Status

Wa-U was being cultivated along with fruit trees such as citrus in backyards and home gardens. In both cases, it was being well taken care of but not mulched with grass. There were many flowering plants observed in Kanpetlet and Yeolongpan, so it seemed that the relationship between flowering and tubers size was not quite well understood. In Yeolongpan, seed tubers were propagated from seeds at home gardens. It was observed in Mindat that Wa-U plants were cultivated just down from the barn and well nourished.

At the large scale plantation in Kanpetlet, 1st to 3rd year plants were cultivated in an orderly fashion on a steep slope with banana plants. Grass weeded from ridges was used for green mulch. The owner of the field said that, tuber sizes harvested were inferior in tree shades.

4) Technique Guidance

A: May 2008: Training of park rangers about the effectiveness of green mulch, cross breeding, propagation from seed, and the methodology of collecting seeds.

B: August 2008: Explanation of conditions for the right land for Wa-U cultivation. It was explained in Yeolongpan that Wa-U plants had been wiped out due to free-range pigs. In fact, *Amorphophallus* sp. plants were cultivated for pig feed in India. The National Park warden requested that the villagers quit free-range piggery as a condition for receiving further cultivation training and received unanimous agreement. It was directed in Hilong to practice good field management such as weeding.
C: March 2009: Following the seminar, all village participants were given on-site training for tuber planting including its angle and depth and thorough green mulch application.

5) Identifying Wild Growing and Cultivated *Amorphophallus* in Natma Taung

As the results of the investigation *Amorphophallus* plants being cultivated in Natma Taung, most were *Amorphophallus bulbifer* Blume. This variety was recorded in India and can be found in an area between India and Myanmar and has the characteristic of growing bulbil on an axil. Local villagers collected Wa-U tubers as seed from the Natma Taung National Park and directly planted in the field. Some varieties of genus *Amorphophallus* have very similar leaves and stems, and no detailed distinction between varieties was made when collecting and they were simply cultivated. The investigation revealed that a total of 3 varieties including two different species were cultivated as Wa-U and of these, the salmon pink and light yellow varieties were identified as *A. bulbifer*, but the white one was identified as *A. napalensis* (Wall.) Bogner & Mayo.

Discussions

For the Chin people that living in the Natma Taung area, Wa-U is not used for food or medicinal purposes and there is no previous record of it having been cultivated as a crop, so it is only within these few years, it has been given a value because of domestic and international buyers and brokers other than the Chin. As such, the park rangers and villagers have very limited knowledge about Wa-U cultivation and physiological traits. In the series of seminars and workshops held, many of the park rangers and villagers participated. It is thought that basic knowledge about Wa-U was imparted to them through konjac. At the same time, the use and planting of Wa-U bulbils was encouraged through the lectures so as to locals understand the need to conserve forest resources. There were questions following the lectures about cross breeding and collection method and we raised hopes towards extension of the seedling-planting cultivation.

In regards to cultivation, home garden and large scale hillside plantation were investigated. Both were bulbil cultivation, in other words reserve tubers harvested in November kept in warm storage inside homes and planted just before the beginning of the rainy season. At the moment there were no injury by continuous cropping observed but with this cultivation method, the continuous cropping may very possibly lead to disease as in the case of konjac cultivation in Japan. Also, it has not been long since Wa-U cultivation has begun so there is still limited understanding of physiological and ecological characteristics of Wa-U and particularities regarding its cultivation. There are also more than a few people who are just beginning to cultivate Wa-U for the first time. In this background, it was thought to be best to promote Wa-U as an intercrop for home gardening. On the other hand, for producers who have already gained a certain level of experience with cultivation, productivity must be improved through terrace farming and array cropping (combination with leguminosae and fruit trees) or adequate fertilization. However, it is important to select the adequate tree variety to be planted together. Also, there is an opinion that thickening of tubers decreases under shade by trees, so perhaps it is not fit for cultivation in areas with too much rain-fall and clouds (Fig. 6).


Fig. 6. Wa-U plants in a home garden.

What must be taken into account is that the local villagers are cultivating Wa-U without understanding what it is used for. In other words, there is the local infarmation that the demand for Wa-U in China is increasing, but in the next project, it would be important to determine the stability of the market and future external demand. At the very least, land for staple corn

crops should not be turned over to Wa-U cultivation and it should be introduced as intercrops for home gardening so that the degree of self-sufficiency with tubers does not decline while also gaining a cash crop.

Any Information of the Wa-U cultivation has not been reported. Therefore, we thought we could instruct based on konjac cultivation methods in Japan due to similarities in physiology and cultivation method.

Seed tubers were either collected from the forest or were grown from seeds, and neither were particularly being selected for planting. Therefore, it was observed that some characteristics of plants in the field were not uniform. Differences in the yielding percentage of the dried slices compared with fresh tubers and mannan content between plants could be expected, but at the moment, these are all traded en masse so at least the producers do not mind this diversity. For example, locally there was a distinction of red, yellow, and white varieties, but there was no research about their characteristics, size of tuber, the yield of bulbils, and quality (dried-slices/ fresh-tuber and mannan content). However, producers wanted to know which variety has good performance and other such information.

Seed tuber production from bulbils and seeds is being trialed by some assiduous producers. Through this process, they will be able to see some variations on characteristics of Wa-U plants and consequently superior lines would be selected. The development of superior cultivars would reduce the benefit of collecting wild plants and solidify the promotion of local Wa-U production. For this, there must be human resource to train and promote producers and for forest resource conservation, and it would be most appropriate for park rangers to take on this job by acquiring appropriate skills. To develop such human resource is perhaps one of the next project's objectives that have been mandated to us.

References

Than Sein, 2003. Seed Bank, Department of Agricultural Research, Yezin, Myanmar.
Japan Konjac Association, 2007. Report for Wa-U production and marketing structure in Myanmar (in Japanese). 32 pp.

7. “Wa-U” Cultivation

Initiative for the Conservation of Species and Establishment as Cash Crop

Shigeo Yasuda, Project Manager

In the area surrounding Natma Taung National Park, a project was initiated to sustainably conserve forest resources and to identify such resources for cultivation as a sustainable source of cash income for the villagers, and to empower National Park staff through skill-transfer for the implementation of the said project (see project implementation details).

In the process of investigating forest resources in the Natma Taung area, it was discovered that local villagers at Hilong village were already cultivating a locally growing wild plant known as “Wa-U”. This was a variety of konjac (*Amorphophallus* spp. – see Chapter IV part 5 for botanical details). It was being cultivated in a field and according to villagers, they have harvested tubers from the forest for sale in Kanpetlet or to be planted in the fields for cultivation. Also, grown tubers were taken into Kanpetlet or Mindat for sale and villagers were getting cash income. Such a situation with mountain harvest and sales was not limited to Hilong village and it was discovered later that the practice was wide-spread in the entire Natma Taung area.

On the other hand, the international NGO, CARE Myanmar, which had started activities in Kanpetlet and Mindat at the same time as our project, was already aware of the value of this tuber and they had selected several villagers two years before this project was initiated, distributed tubers, and had been promoting its cultivation. Additionally, there was a plot in the backyard of their office in Kanpetlet where some seeds were germinating and there were efforts supporting proliferation. However, at the office of CARE Myanmar, there were no agricultural experts and cultivation methods were transferred to villagers after an internet based search.

In such a situation, it was easily imaginable that, considering the extremely low income situation of the village, if mountain harvesting and sales continued for cash income, wild species may disappear from surrounding forests, leading to the “depletion of forest resources”. On the other hand, Wa-U was a local plant resource and to utilize this was to achieve the project objective of making use and cultivating an identified economic plant to provide sustainable cash income for the local community.

Therefore, targeting Wa-U, for which skill transfer and professional cultivation methods have not been properly transferred to date, the below initiatives were implemented and its results will be reported here.

Cultivation

Between June and July of 2007, tubers were planted in three model villages. The planting took place in May of the following year (2008) and in March of 2009 for a total of three times. At the end of June 2009 to the end of the project period, it can be said that future strategies for securing sustainable cash income has been determined through cultivation method, processing method, and propagation method identification (three methods: seed sowing, bulbil planting, replanting split tubers).

Project Details

1) 2007

At Oak Pho, Yelongpan, and Hilong villages, ridges were prepared in the field for joint planting by the villagers and tubers were harvested from the mountain and distributed for planting.

Lessons learned:
A. Planting was too late

Planting took place between June and July but as seedlings taken from the mountain already had stems as long as 30cm, and it is thought that at this point, growth had momentarily suspended.

B. Planting depth was too deep
Konjac roots spread from above the tuber and creep outwards. If it is planted too deep, it would prevent plant growth. It would be better to plant in shallow ground and put about 2 to 3 cm of soil on top.

C. Proper mulch was not applied
Applying mulch is essential to prevent weeds as well as for fertilizing and keeping moisture.

D. Harvesting was too late
It is better to dig up tubers as soon as the stem falls and concurrently with bulbil harvesting. If time passes after the stalk falls, the stem immediately starts to rot and becomes very hard to distinguish from the floor and it becomes difficult to know where the tubers are. Even if villagers try to dig in approximate areas of the tuber, it may end up damaging the tuber. Also, bulbils will be scattered around the ground and become very hard to harvest. It would be better to start digging up tubers, starting from stalks that have become yellow and collapsed.

E. In the first year, the minimal required amount of seed tubers was harvested from the mountain.

2) 2008

Learning from the lessons of the previous year, planting was done earlier and systematic field preparation and planting were implemented. Also, records of planted tubers were taken. It can be said that proper Wa-U cultivation started from this year.

Fig. 1. U Shein Gay Ngai giving welcome remark.

Fig. 2. Lecture by U Tin Maung Soe.

Planting Period:
Oak Pho village: April 29 and May 6
Yelongpan village: April 18
Hilong village: June 4 to 6

Implementation of a Seminar: Prior to planting, Kanpetlet villagers and those from around the villages were invited to the seminar on Wa-U cultivation.

Event date: March 17
Venue: Kanpetlet, SPDC Office
Lecturer: U Tin Maung Soe (affiliated to MAS under the Agriculture and Irrigation Ministry) was invited from Yangon
Participants: About 120

Fig. 3. Participants packing the venue.

Seminar Content:
The lecture was two parts, consisting of a morning lecture (Wa-U and coffee cultivation) and post-lunch field training of Wa-U planting on a field of U Myat Maung.

Because of increasing demand for konjac from Yangon and Mandalay, it was evident that villagers from and around Kanpetlet were very interested in learning about cultivation methods. The lecturer U Tin Maung Soe himself had already started cultivation of coffee and Wa-U in Pyin Oo Lwin , and had high hopes of increased cultivation in the project area.

Fig. 4. Many specific questions about the cultivation were received

Fig. 5. Field training was conducted at U Myat Maung's fields.

Fig. 6. Instruction for corm planting.

Cultivation:
Overall assessment is as follows:
Oak Pho village: The land was good and harvest was the best here.
Yelongpan village: The entire crop was decimated due to free-range pigs. Humans are short of food and so are pigs. As there is not enough food waste, aside from in the towns, pigs are generally left to roam and are not particularly fed. As such, Wa-U became perfect food for pigs. Although they are technically "free-range", they are usually hanging about homes and fields far from the village rarely suffer from such damage.
Hilong village: Bad soil condition and bad harvest.

Processing Instruction:
Using a slicer acquired from Yangon, locals were instructed how to make thin slices of the tubers. The slicer was distributed to each model village. It was a new tool that the villagers have seen for the first time. Gloves were also distributed so as not to cut their fingers.

3) 2009

Changing the Cultivation Method in Model Village
In the first and second years of the project, fields were prepared in each model village for cultivation. This method worked when everybody was working together, but when it came to weeding, there was no personal benefit so it often became neglected. Therefore, in the last year, this method was halted upon discussion with the park rangers and tubers and bulbils were distributed to each household and they were asked to individually cultivate. This is because with ownership, there would be greater care given.

Organization of a Seminar:
Following the success of the seminar in the previous year, another seminar was organized in Kanpetlet and Mindat. A lecture and field training delivered by cultivation experts from Makino Botanical Garden (MBK) was attended by a very attentive audience who did not miss a word and asked enthusiastic questions.

It can be said that this was quite rare in Myanmar. Generally speaking, they would usually receive a unidirectional lecture from a superior and not many questions would be asked even when solicited.
Event date: Kanpetlet, February 24;
Mindat, February 26
Venue: Kanpetlet, SPDC office;
Mindat, SPDC office
Lecturer: Mitsuo Matsumoto, MBK.
Participants: Kanpetlet, 120; Mindat 150
Seminar content: The lifecycle of Wa-U, process of pollination, points to be aware about cultivation, propagation, and the preparation and effectiveness of fertilizer from pig manure.

Wa-U cultivation is in boom in a manner of speaking, and this made the communication of the importance of cultivation and propagation more pertinent. Also, the tax and import regulations of

Fig. 7. Lecture on the process of pollination. Kanpetlet.

Fig. 8. U Shein Gay Ngai stressing the importance of green mulching following planting. Kanpetlet. Mr. Matsumoto on the left edge

Fig. 9. U Myat Maung lecturing on the processing of tubers using a slicer. He has the most advanced farming operation in Kanpetlet.

Fig. 10. Scenes from the lecture at Mindat. The lecture by Mr. Matsumoto was translated by Project Manger Yasuda into English, then further translated to Myanmar by U Shein Gay Ngai.

Fig. 11. A break between the lectures. Mindat. Information exchange with two staff from the international NGO, CARE Myanmar about respective projects.

Fig. 12. Mr. Matsumoto giving directions for green mulching at planting on a field that was temporarily prepared in front of the venue, Mindat.

the importer, Japan and safeguards enacted in the same year were introduced and the dangers of monoculture were also stressed to promote a "Multi-culture Home Garden" that combined tea and coffee cultivation. Also, it was a good outcome that pig manure fertilizer, which could be available locally with no additional cost, was promoted to as many participants as possible. There is a need to promote this fertilizer production so that it can be adopted locally. This is because increasing the production of vegetables and cultivation output with no additional cost is directly connected to improving the livelihood of the locals.

Fig. 13. May 20, 2009 Yelongpan village. Owing to the effectiveness of the seminar, the visited fields had the correct green mulching techniques applied.

Cultivation Method:
The cultivation skills were transferred through the seminars and field instructions over the past two years. In this project year, the importance of adding green mulch (utilizing grass stems of monocotyledons) when planting was emphasized.In each village, planting demonstration was implemented and the above instruction was given. Green mulch adds potassium and contributes to the growth of tubers and prevents weed growth, greatly lightening the load of farm work during the rainy season. The importance of decreasing the workload for weeding cannot be emphasized enough.

Information Dissemination:
In addition to skill transfer through the seminars to the villagers and those in surrounding settlements, laminated posters with information on Wa-U lifecycle and points regarding cultivation were posted in common areas where many people gather, such as the phone office and coffee shops in Kanpetlet.

Fig. 14. U Om Ling Htang putting up a poster on the wall of the phone office.

Conclusion, Reference, Advice for the Future

In 2007, there was a decline of konjac harvest in Japan due to typhoons and there was increased demand for dried konjac slices from Myanmar. Demand was so high that an exporter from Yangon claimed that supply was scarce and difficult to meet. Export to Japan from Myanmar increased to the point where a safeguard was announced by the Japanese government in February and March of 2009.

Exorbitant Japanese import taxes on konjac (regardless of fresh corms or dried slices) of 1,705 % is not unrelated to the main konjac producing prefecture of Gunma and how it is called the "political prefecture", but it is unrealistic that such a tax would continue due to future WTO negotiations. By expecting trade liberalization, many Japanese konjac producers are already looking intently at the potential of expanded import from Myanmar.

The mountainous areas in Chin State (at an elevation higher than 1,500 to 1,600 meters) are fit for wild konjac growth due to its cool climate and limited sunlight during the rainy season (that negates the need for applying shading net), with the added benefit of a long dry season (most ideal is February) that is good for sun drying. There was no mold growth due to high humidity like in cultivation around Yangon (at least there were no evidence of disease or parasites on the leaves and stored corms during the project period) and as long as green mulch is applied, workload is also limited. It can be said that it is an ideal cash crop for the people living in high altitudes who have no experience working on normal agricultural fields.

As has been mentioned, although trial and error were repeated, it is thought that cultivation and propagation methods have mostly been determined through the project implementation period. It is thought that points to be addressed in the future are as below.

1) Implementing Selective Breeding:

At the moment, we are at a stage where wild varieties harvested from the mountain are being cultivated in the field. Therefore, uneven harvest per stalk can't be ruled out. In the future, varieties that produce larger tubers and bulbils would be selected from the currently cultivated lot and an effort will be made for their

proliferation. There are several people within Kanpetlet who can implement such selective breeding. It has to be somebody with sufficient economic background so that he can wait a few years for a good result, and those who can learn and understand the importance of selective breeding. The exact names of these potential participants are as follows: U Hong Mang (ranger), U Thang Hleigh (konjac farmer), U Myat Maung (orange orchard owner), U Om Mana (an advanced farmer in Yelongpan).

2) Initiative for Propagation:

Varieties harvested from the mountain are cultivated and bulbils are also collected and these are planted as well. These are the current methods of cultivation, and it is necessary to increase the variety of planting methods, such as collecting seeds and sowing them or splitting tubers for planting. It is especially important to use seeds for rapid proliferation and selecting good varieties, and this process must be pursued diligently. Seed production is usually shunned as it takes far more time for cultivation than mountain harvesting, which is currently widespread and very easy. It is impossible to ask all growers to adopt this seed production. It is ideal for individuals identified above in 1) to be targeted to explain the benefit of this method at great lengths to convince them, and a small nursery should be built in each individual farm for selective breeding with diligent weeding, allowing for field planting to be realized in about 2 to 3 years.

3) Spreading the Practice of Fertilizer Production:

Much of the soil in Natma Taung is low in fertility and fertilizers influence the harvest greatly. The Chin people who are people of the forest have limited knowledge about soil conditioning. Adding fertilizer other than from slash-and-burn ashes is rare. Free-range chicken and pig manure are also not used and simply left to scatter. Promoting a mixing of pig manure on chicken droppings and hay for periodic fertilization is a method that can be introduced without additional cost and it can contribute to successful konjac cultivation and daily food production.

4) Promoting Processing and Sales:

Up to this point, local villagers carried tubers harvested from the mountain in sacks and walked a long way to Kanpetlet town for very little cash income (500 Kyats per 1 viss, or approximately 50 cents per 1.6 kg) to purchase daily goods and return to their village. If they process these tubers into dried slices and sell them instead of selling them raw, they would be able to put additional value and transportation itself would be much easier. Even though such things were said to people in the villages visited before, they wanted instant cash and it was hard to convince them of the benefits for implementation of this processing. More so, distributing tubers and bulbils to the villagers through the project time was meaningful to economically support the beginning of this cultivation to assist its take up and put its process on track.

5) Promoting Cultivation Methods that are Locally Compatible:

Soil conditioning through fertilizer production and field preparation, tuber planting method, timing for planting, recognition of the importance of green mulching, and decision for the most ideal time for harvesting were points that needed to be widely disseminated amongst the local citizens. The method of dissemination should be discussed with the Park Warden U Shein Gay Ngai and the ranger U Hong Mang and U Om Ling Htang and planned for implementation. Previous experience and consultation suggest that the following are effective methods:

- Putting up posters where villagers and townsfolk congregate;
- Producing a 15 minute demo DVD, distribute them to DVD houses in town and screen them (Perhaps a preliminary co-production with U Aung Din by providing demo footage. Slideshows are also sufficient);
- Continuing the organization of seminars (this should be included in the activity schedule for the next project and continued);
- Providing reference materials to Christian missionaries and Buddhist monks so that they can distribute them when on missions to remote villages (Suggested by U Om Ling Htang. Very effctive way for disseminating in wider region).

The objective of this report is to summarize and promote the outcome of three years of project work conducted between September 2006 and June 2009 for the "Education and training of Myanmar personnel for the realization of phyto-diversity conservation and sustainable use of plant resources to improve economy of the rural population" (Japan International Cooperation Agency Partnership Program).

Also, because the project site and the entire Natma Taung National Park area in Chin state, Myanmar is still (as of June 2012) a restricted area for foreigners to visit, up to this point there is very little basic information available about the local livelihood and culture. The project manager recorded such information while staying in the field through the 2 years of project work. We believe that substantial information about the background of local social issues has also been gathered.

We do hope that the readers of this report will take into account such social background and utilize the results and findings from this project.

“Education and training of Myanmar personnel for the realization of phyto-diversity conservation and sustainable use of plant resources to improve economy of the rural population”

Japan International Cooperation Agency (JICA)
Partnership Program (September 1, 2006 – June 31, 2009)

Partner Institution:

Nature and Wildlife Conservation Division (NWCD), Forest Department
Ministry of Environmental Conservation and Forestry, Republic of the Union of Myanmar

Cooperating Institutions:

JICA Myanmar Office, Yangon, Myanmar
Queen Sirikit Botanic Garden, Chiang Mai, Thailand

Collaborators:

Myanmar:

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U Shein Gay Ngai, Park warden; U Hong Mang, Daw Ling Shein Man, U Htun Pe, U Ling Kee, U Aung Htay, U Maung Nu, U Aung Zaw Ling, Park rangers, Natma Taung National Park Office
U Om Ling Htang (Translator, Assistant to Project Manager), Kanpetlet

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Dispatched Experts: Dr. Santi Watthana, Dr. Prachaya Srisanga, Mr. Mano Thamaragsa, Mr. Paisan Thongsorn

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