Conservation and Sustainable Management of Butterflies *in situ* for Recreation in Doi Nygem, Mae Fah Luang University, Chiang Rai

Ratna Thapa

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Ratna Thapa
School of Science, Mae Fah Luang University
Chiang Rai

PREFACE

Butterflies, a bioindicator of global warming, are increasingly being recognized as valuable environmental indicators, both for their rapid and sensitive responses to subtle habitat or climatic changes and as representatives for the diversity and responses of other wildlife.
Butterflies have been admired for centuries for their physical beauty and behavioral display. These colorful insects frequent open, sunny wildflower gardens, grassy fields and orchards, feeding on nectar from flowering plants. Butterflies belong to the order Lepidoptera, which means scale-winged. The order contains over 19,000 species of butterflies and 100,000 species of moths worldwide. Over 700 butterfly species occur in North America.

The complex butterfly life cycle includes existence as an egg, larva (caterpillar), and pupa before developing into an adult butterfly. Larvae and pupae of different species were collected from different areas of Mae Fah Luang University and adjoining area villages of MFU were reared in the laboratory for breeding. The sites represented major farming and forest areas.

Butterflies are beneficial as pollinators, silk producers, indicators of environmental quality, and are appreciated for their aesthetic value. The holometabolous life history of butterflies reveals that Lepidoptera are exposed to a wide range of environmental influences, and they are highly sensitive to changes in temperature, humidity and light levels

Doi Nygem is the one of the most protective area for breed of bird wing butterflies. This species has been already listed as an endanger species in RED Book of IUCN.

ACKNOWLEDGEMENT

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I am grateful to Mae Fah Luang University for providing the research funds for this research.

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Ratna Thapa

EXECUTIVE SUMMARY

Butterflies, a bioindicator of global warming, are increasingly being recognized as valuable environmental indicators, both for their rapid and sensitive responses to subtle habitat or climatic changes and as representatives for the diversity and responses of other wildlife. Butterflies have been admired for centuries for their physical beauty and behavioral display. These colorful butterflies like open, sunny wildflower gardens, grassy fields and orchards and feed on nectar from flower to flowers. Butterflies belong to the order Lepidoptera, which means scale-winged. The order contains over 19,000 species of butterflies and 100,000 species of moths worldwide. Over 800 butterfly species occur in Thailand.

The aim of this research were to select the captive breeding species of butterflies for commercialized, establishment of a butterfly farm at Mae Fah Luang University in order to provide the education opportunities and entertainment to students, ethnic communities, and young children in the field of biodiversity. Larvae and pupae of different species were collected from different areas of Mae Fah Luang University and adjoining area villages of Mae Fah Luang University. Four species of butterflies namely: *D. chrysippus, Papilio demoleus*, *P. polytes* and *G. agamemnon* were captive bred in the laboratory of Mae Fah Luang University. The life cycle of *D. chrysippus* was studied in the laboratory. Adult butterflies were had lifespan for 35-60 days under the natural condition. Egg stage was 3-5 days, larvae period 14-16 days and pupal stage 8-9 days. *D. chrysippus* was observed all around the year. The three other species of butterflies studied reared in the laboratory were *P. demoleus*, *P. polytes*, *G. Agamemnon* and *G. narina*. *P. demoleus* was observed from March to July, *P. polytes* from mid of May to August, *G. Agamemnon* February to June, *T. limniace* from February to mid of August and *G. narina* from January to mid of March. There are around 22 species of butterflies are available around the university. Doi Nygem is the one of the most protective area for breed of bird wing butterflies. This species has been already listed as an endanger species in RED Book of IUCN.

ABSTRACT

Butterflies, a bioindicator of global warming, are increasingly being recognized as valuable environmental indicators, both for their rapid and sensitive responses to subtle habitats or climatic changes and as representatives for the diversity and responses of other wildlife. The objective of this research was to select captive breeding species of native butterflies to establish a butterfly farm at Mae Fah Luang University to provide education opportunities and to students, young children, and visitors for income generation of Mae Fah Luang University and conservation of biodiversity. Eggs collected from host plants were kept in petri dishes lined with moist tissue paper to keep from drying out and incubated at 26-28°C. Larvae collected from several species of host plants around Mae Fah Luang University, Doi Tung and Nan were reared in plastic boxes in the laboratory at 26-28°C and 68-80% relative humidity. The larvae were kept separately in separate plastic boxes to avoid overcrowding. The larvae were fed daily with fresh leaves. After 3 days of pupation, the pupae were stick on cardboard with glue and kept at room temperature 26-28°C and 68-80% RH. The adult butterflies were fed with 10% honey syrup and released in the field. During the eggs and larvae collection, the species of host plants were also recorded. The results show that 6 species of butterflies *viz*; *Danaus chrysippus*, *Papilio demoleus malayanus*, *Moduza procis*, *Graphium Agamemnon*, *Tirumla limniace*, and *Gandaca narina* were successfully reared in the laboratory. In conclusion, four out of six selected species can be captive breeding in the laboratory for commercial purposes.

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CHAPTER - 1
INTRODUCTION

1.1 Background

Butterflies, a bioindicator of global warming, are increasingly being recognized as valuable environmental indicators, both for their rapid and sensitive responses to subtle habitat or climatic changes and as representatives for the diversity and responses of other wildlife. Butterflies have short life cycles and react quickly to environmental changes. Their limited dispersal ability, larval food plant specialization and close reliance on weather and climate make many butterfly species sensitive to fine changes. Recent research has shown that butterflies have declined more rapidly than birds and plants emphasising their potential role as indicators. Butterflies are sensitive to changes in the habitat and are, therefore, important candidates for biomonitoring (Pearson, 1994). They are sensitive to floral diversity, vegetation structure (Brehm *et al.,* 2003) and structural components of the habitat (Hill *et al.,* 2001). Butterfly decline signals 'biodiversity crisis'.

Lepidoptera are beneficial as pollinators, silk producers, indicators of environmental quality, and are appreciated for their aesthetic value. The holometabolous life history of butterflies reveals that Lepidoptera are exposed to a wide range of environmental influences, and they are highly sensitive to changes in temperature, humidity and light levels (Vane-Wright and Ackery, 1984; Erhardt, 1985; Collins and Thomas 1989; Kremen, 1992). Increases in human population combined with advances in technology have directly subjected the ecosystems of the world to changes to which many Lepidoptera and other organisms cannot adapt. There is thus a need to develop long term resource management policies for these ecosystems based on an understanding of the ecological processes involved in their maintenance, ensuring a sustained yield of agricultural or forest products for human benefit as well as reservoirs of natural habitat to maintain biological diversity. Habitat degradation is currently the biggest threat to tropical insects; however, the effects of climate change may soon be more pervasive (Chen *et al.,* 2009). As indicators of environmental disturbance or environmental change, butterflies are frequently used because they

offer a number of logistical advantages over other potential indicator taxa (Thomas, 1991; Ghazoul, 2002; Koh and Sodhi, 2004; Gardner *et al.*, 2008).

1.2 Statement and significance of this research

Butterflies are very sensitive bioindicator of ecosystem health, and are excluded from communities along with their larval food plants in-response to various management histories of overgrazing by domestic livestock or the exclusion of historical fire patterns. Doi Nygem is highly diverse in invertebrate, and vertebrate animals might be a good conservation site of vertebrates, and invertebrates. There has been no survey and research conducted on the biodiversity of Doi Nygem. There is not scientific data on the butterfly fauna of Doi Nygem. It is urgently needed to do survey and scientific study butterfly diversity in Doi Nygem. Conservation and preservation of biologically diverse in Doi Nygem wound be the best *in situ* sources of study of biodiversity of invertebrates as well as vertebrates at Mae Fah Luang University. Mae Fah Luang University will be an international research centre for scientific researches of butterflies as well as entertainment opportunity *in situ* for local and international tourists. Mae Fah Luang University butterfly rearing centre will help to prevent decline of native species of butterflies from their natural habitats. The butterfly rearing project is also necessary to achieve the objectives of conservation of biodiversity in order to understand how organisms and the environment interact.

1.3 Objectives

- To select the captive breeding species of butterflies to establish a butterfly farm at Mae Fah Luang Universityto provide the education opportunities and entertainment to students, ethnic communities, and young children in the field of biodiversity,
- To prepare the checklist of Mae Fah Luang University butterflies,
- To find food plants and other life history information of butterflies especially rare and highly valuable butterflies. Determining the food plants of butterfly larva will help greatly in establishing butterfly farms, and
- To record the status of rare and red-data book butterflies.

1.4 Significance of this research

1.4.1 Educational opportunities

This project has direct and indirect benefits:-

- Local communities
- Students
- Other groups

1.4.2 Local communities

- Negative influences have been found on habitat disturbance and herbicide use on butterfly communities. Herbicide used in the local area also killed many honey bees that people raise.
- Local people know my butterfly research for conservation will positively affect them.
- Ecology and biology such as life cycles, food plants of butterflies will be help in breeding butterflies in insect farms at Mae Fah Luang University, Thailand.
- Volunteers understand the value of butterflies and will contribute their effort and ability for nature and environmental protection in their countries.

1.4.3 International communities

By the website, scientists from other nations knew about the work and contacted us. The work also affects volunteers. Through the research they understand the butterflies, the importance of forest and habitat for butterflies Mae Fah Luang University, and Thailand.

1.5 Sustainability benefits of this research

The findings of food plants, lifecycles, habitat preference, distribution and other information on butterflies are valuable to conserve butterflies and especially help to breed butterflies in insect farms and also conserve nature forests. People must grow food and nectar plants in the gardens to feed butterflies that also create and protect forest. Farmers can get income from exporting insects from their farms.

1.4.1 Economic benefits

- Attracting more people to visit Mae Fah Luang University, Mae Fah Luang Butterfly Farm, Botanical garden and Mae Fah Luang University Museums, creating a positive effect on the local economy.
- Elevating the image of Mae Fah Luang University with benefit to tourists and tourism fields.

1.4.2 Social benefits

- Providing additional opportunities for people to develop their careers butterfly farm.
- Helping the grass-root level people and the under-privileged to enjoy a better quality of life.
- Providing therapeutic services, through adaptive butterfly farm, to people with disabilities.

1.4.3 Recreational benefits

- Offering additional opportunities to the people of Chiang Rai, and northern parts of Thailand, in learning and culturing butterflies.
- Constructing more educational and recreational facilities on Mae Fah Luang University for families to enjoy, such as environmental protection, science, scientific tourism for children. .

CHAPTER – 2
LITERATURE REVIEW

2.1 Butterfly diversity

Butterflies have been admired for centuries for their physical beauty and behavioral display. These colorful insects frequent open, sunny wildflower gardens, grassy fields and orchards, feeding on nectar from flowering plants. Butterflies belong to the order Lepidoptera, which means scale-winged. The order contains over 19,000 species of butterflies and 100,000 species of moths worldwide. Over 700 butterfly species occur in North America.

Butterflies have several staged of lifecycle, and migration and hibernation activity in some species. The complex butterfly life cycle includes existence as an egg, larva (caterpillar), and pupa before developing into an adult butterfly. The resiliency of some butterfly species is illustrated by their ability to travel great distances. The Monarch, perhaps the most commonly known species in the United States, journeys more than 2,000 miles to winter in warmer climates. The life span of adult butterflies ranges between one week and eight months, and averages two to three weeks in length.

The life history of butterflies includes extremely short adult life spans in some species, a four-staged lifecycle, and migration and hibernation activity in some species. The complex butterfly life cycle includes existence as an egg, larva (caterpillar), and pupa before developing into an adult butterfly. The resiliency of some butterfly species is illustrated by their ability to travel great distances. The Monarch, perhaps the most commonly known species in the United States, journeys more than 2,000 miles to winter in warmer climates. The life span of adult butterflies ranges between one week and eight months, and averages two to three weeks in length.

Land use changes and development have resulted in significant losses of native butterfly habitat across the United States. As a result, the popularity of wildflower gardens and plantings to attract butterflies and other valuable pollinating insects and birds has increased. Historically, butterfly enthusiasts collected butterflies with nets and preserved them in display cases for viewing. Fortunately, during the past few decades appreciation for butterflies has been evolving from these consumptive uses to conservation measures. An increased knowledge and understanding of the importance of butterflies and the symbiotic balance that exists between them and the plant species they pollinate and rely on for food has helped to foster this transition

2.2 Distribution and range

Butterflies have nearly global distribution, present on every continent except Antarctica. The butterfly species found in North America that are covered in this leaflet belong to six families containing numerous subfamilies. Within the Thailand, the ranges of individual butterfly species, as well as individual butterflies within those species, vary with migration habits and geographic region. A species inhabiting a warmer region may have a small range, whereas a species inhabiting a region with a winter season may migrate to warmer climates in colder months, thus possessing a much larger range.

2.3 Habitat requirements

Throughout the United States, butterflies can be found in and around a multitude of habitats ranging from sunny, dry open meadows to shaded, damp woods. Among the many habitats in which butterflies live are backyards, wildflower gardens and meadows, open brushy areas, old fields, open grassy woodlands, wooded stream-sides, hardwood and coniferous forests, willow swales, birch-aspen forests, citrus groves, marshes, wet meadows, woodland edges, disturbed areas, roadsides, cut-over and second-growth forests, mountainous regions, lowlands, still canyons, deserts, flats, sand dunes, and shore areas. In order to complete its life cycle, an individual butterfly may require multiple vegetation types to satisfy its food and cover needs.

Host plants (plants fed upon by caterpillars) often differ completely from the vegetation required by adult butterflies, which are commonly nectar sources. Caterpillars feed on a variety of trees, shrubs, herbs, legumes, forbs, grasses, and sedges; whereas adult butterflies feed from a variety of flowering plants and wildflowers. Because Lepidopterans are so widely distributed and diverse in the types of foods they eat, butterflies forage in nearly all habitat types in the regions they inhabit. The cover provided by crevices in tree bark, log piles, cracks in buildings, and butterfly boxes provide hibernacula for overwintering butterflies. The removal and alteration of flowering trees, shrubs, vines, natural wildflower meadows, native prairies, woodlands, wetlands, brushy areas, hedgerows, and other natural vegetation and the general intensification of rural land uses has reduced habitat quality and availability for many butterfly species. By preserving woodlands, open grassy areas, and wildflower meadows, and providing additional food and cover sources through tree, shrub, grass, and wildflower plantings, landowners can assist in the survival of butterflies and other species that rely on similar habitat.

2.4 Food

With the exception of a few species whose caterpillars feed on aphids and ants, butterflies rely nearly entirely on plants for food. Hundreds of different plant foods are eaten by butterflies in the United States. Plant foods preferred by the caterpillar of a butterfly species often differ from those preferred by the adult. Caterpillars feed on the leaves of trees and shrubs, garden perennials, vegetables, wild legumes, wildflowers, grasses and weeds. Adult butterflies rely almost solely on nectar for food. Adults of some species also obtain nutrients and minerals from rotting fruit, tree sap, animal dung and urine, and carrion. Although some butterfly species prefer one food plant over another, many species are generalists, opportunistically feeding on whatever plants are available. On the other hand, some species specialize on particular plants, and only occur where these host plants exist. Lists of common caterpillar food plants and adult nectar sources are provided in the appendices on pages 9-11.

2.5 Cover - plants

Cover needs of butterfly caterpillars are typically met by host food plants. Feeding caterpillars often blend in with host plants or are hidden by their foliage. Leaves of trees and shrubs provide adult perching sites for feeding, sunning and loafing and provide overhead cover from wind and rain. Leaves and branches of trees, shrubs, wildflowers and other plant types serve as substrates for butterfly eggs as well. Grasses and soil harbor eggs of butterflies that broadcast them over an area rather than laying them directly on vegetation. Grasses and soil also provide perching and roosting sites for adults. Adults may hibernate in tree bark crevices or under exfoliating bark. Tangled thickets, hedgerows, and vines also conceal butterflies from predators and provide protective cover from wind and rain.

2.6 Cover - other

Rock piles, log piles, and open buildings are a few structures that provide protective cover and hibernacula for butterflies. Their adaptive nature enables butterflies to occupy virtually any dry structure or area that provides protection from wind and predators and a warm or sunny environment.

2.7 Cover - winter

Most winter butterflies spend the winter in larval stages in various types of leaf litter and plant material. Those species that over-winter as adults generally require cover in the cold season similar to that required in other months. Thick vegetation located in valleys, lowlands, or on southeast facing slopes provides necessary protection from cold winds. Most of the butterflies spend winter in the larval stages in various types of leaf litter and plant materials.

2.8 Water

Water requirements of caterpillars are partially met by consumption of green vegetation, whereas nectar provides adult butterflies with adequate water. However,

adult butterflies will "puddle," or gather to drink, at small mud puddles, birdbaths, and damp sandy areas. Butterflies will also puddle around campfire rings, urine spots,

2.9 Interspersion of habitat components

In order to ensure successful butterfly reproduction and survival, all required habitat components must be available in close proximity. Vegetation diversity is most important in areas that support overwintering butterflies, as the area must provide all vegetation types necessary to support all four life cycle stages. Ideal interspersion of butterfly habitat components consists of a closely-spaced complex of diverse vegetation consisting of caterpillar food and nectar-producing plants (trees, shrubs, wildflowers, legumes, and grasses), open water and puddling areas, rock and log piles, and other structures that provide cover.

2.10 Minimum habitat area

Although butterflies may forage in areas as large as several square miles, no reasonable estimate of minimum habitat size exists for butterflies as a group. A species can potentially be found anywhere within its range wherever adequate caterpillar and adult food and cover plants exist. These ranges vary greatly by species. Also, large colonies of butterflies may require proportionally greater foraging areas than individuals. Because most adult butterflies share similar ecological requirements as adults, many different species may inhabit the same habitat type. Territoriality exists among adult male butterflies, and is most commonly seen around puddling sites. Males establish territories to improve chances of mating, and compete for space both inter and intraspecifically. Territories are not large in size (sometimes as small as one or two square yards); thus, many territories may exist within a single group of butterflies in an area. Minimum habitat size is not usually a limiting factor for most generalist species.

CHAPTER-3
RESEARCH METHODOLOGY

3.1 Study sites

Larvae and pupae of different speceis were collected from different areas of Mae Fah Luang University and adjoining area villages of Mae Fah Luang University. The sites represented major farming and forest areas.

3.2 Eggs culture

Eggs were collected immediately after laying on the leaves of *Asclepias* sp. (Asclepiadaceae). The eggs were kept in a small transparency plastic box and incubated at 25-28°C. The eggs were kept in a container lined with moist paper towel to keep from drying out. Three to five days old larvae were transferred straight to the host plants in rearing cages.

Figure 1. Eggs of *D. chrysippus* on *Asclepias* sp.

3.3 Rearing of larvae

Larvae were collected from several speceis of *Asclepias* sp. around Mae Fah Luang University, Chiang Rai, and Nan provinces for captive breeding. The larvae collected from *Asclepias* sp. were reared plastic boxes in the laboratory at 26-28°C and 68-80% relative humidity (RH). The larvae were kept separately in separate plastic boxes to avoid crowding. The larvae were daily fed with fresh leaves of *Asclepias* sp.

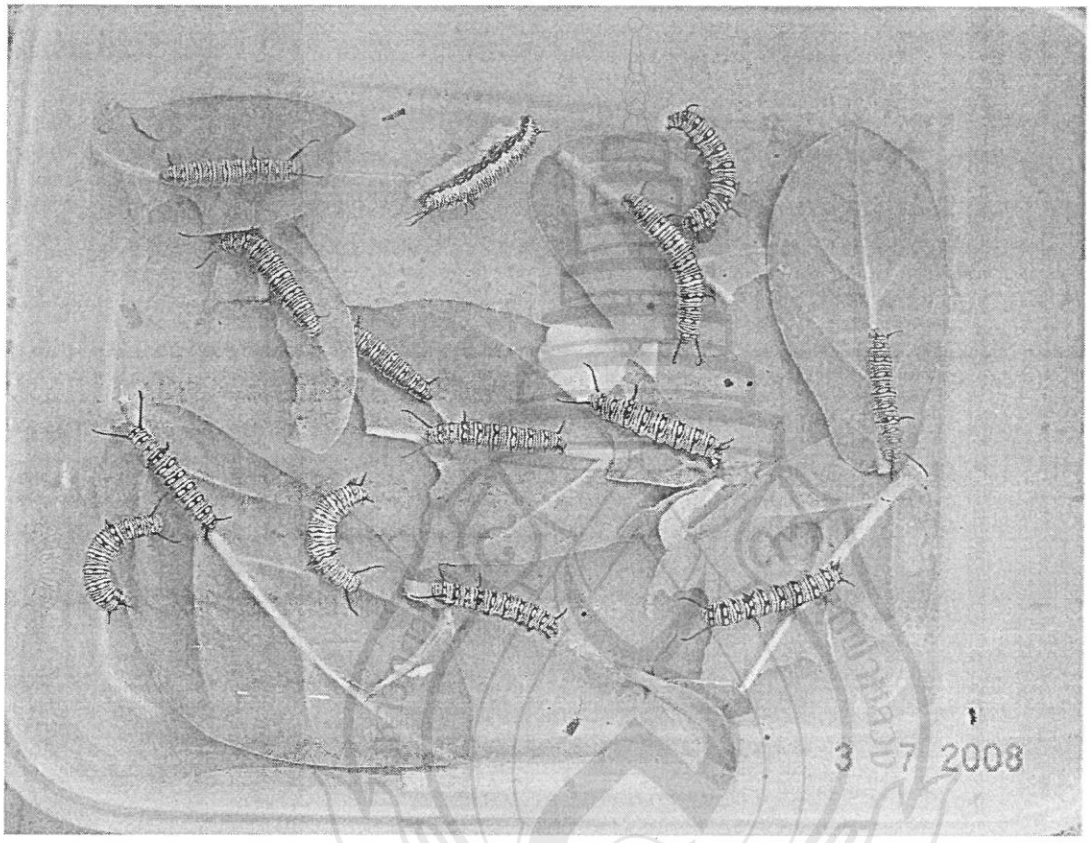


Figure 2. Rearing of larvae of *D. chrysippus* in the laboratory of Mae Fah Luang University.

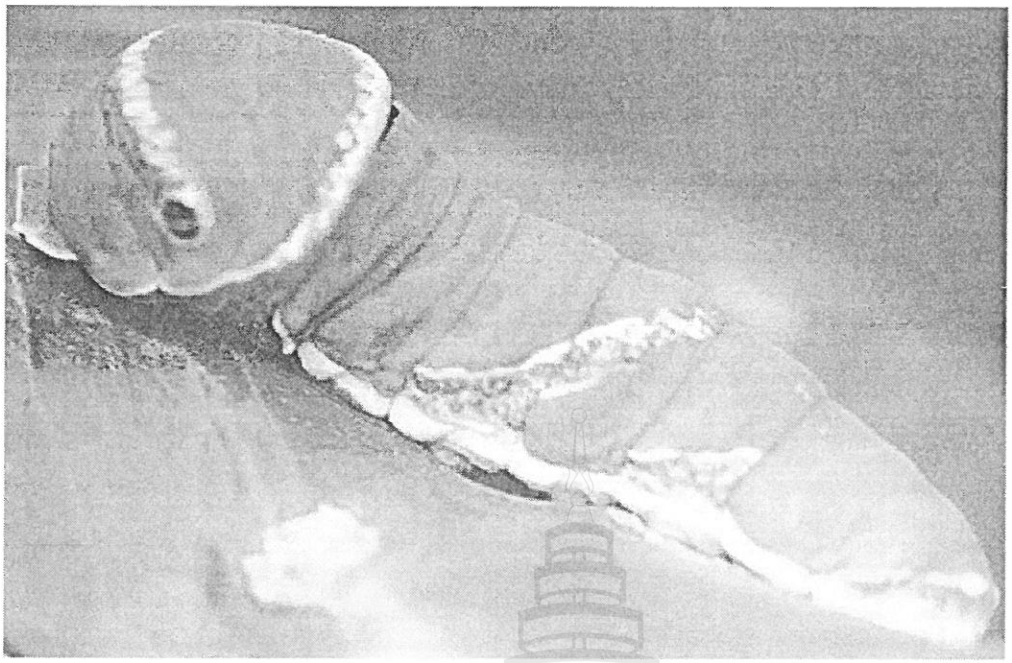


Figure 3. Larvae of *P. polytes* in the laboratory of Mae Fah Luang University.

3.4 Rearing of pupae

The larvae after pupate were not removed for 3 days, let them harden properly. After 3 days, the pupae were stick on cardboard with super glue and kept at room temperature 27-28°C and 85% RH.

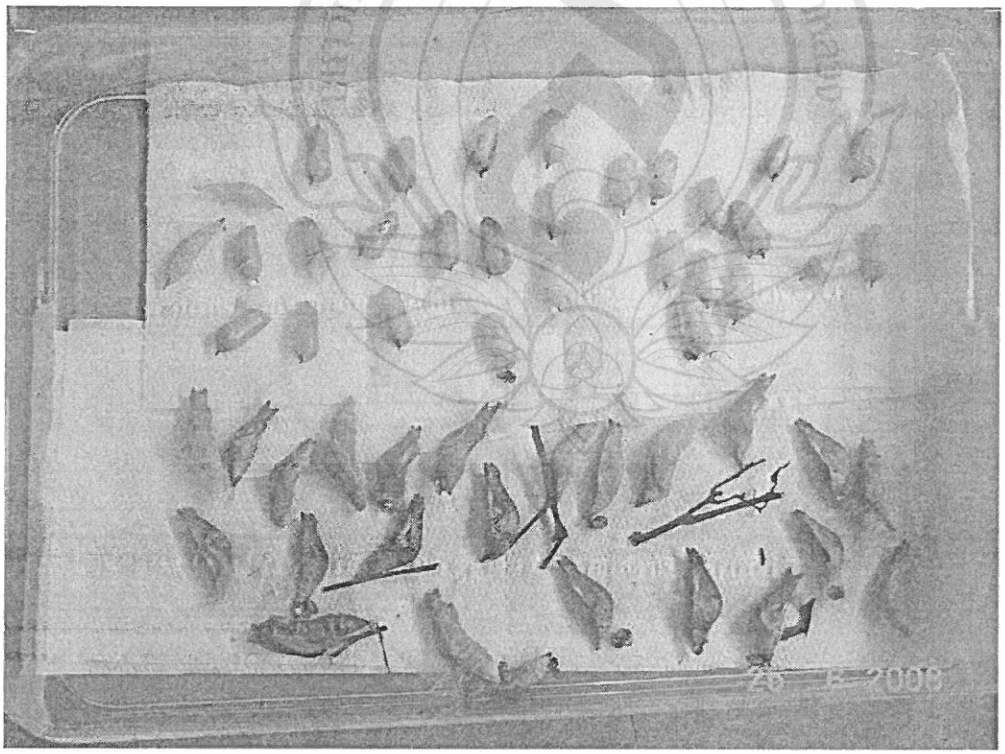


Figure 4. Pupae of three species of butterflies reared in the laboratory

3.5 Release of butterflies

The newly emerged adult butterflies were not handled for the first 4 or 5 hours. They were kept in the cage and fed with 10% honey syrup until the next day. The butterflies emerged from the pupae in the laboratory were released in the host plant growing area.

Figure 5. *D. chrysippus* (female) lying egg on milkweed plant

3.6 Determination of host plants

During the collection of larvae, host plant species were also recorded. All collected host plants were sent to the expertise, J. Maxwell, Curator, Chiang Mai University Herbarium, Biology Department, Chiang Mai University, for identification.

3.7 Butterfly sampling

Butterfly sampling was conducted to develop a checklist of MFU butterflies. We (I and our first year students sampled butterflies monthly from Doi Nygem and the field of Mae Fah Luang University. The butterflies were sampled between 13:00 to 12:00 hours. The butterflies observed were photographed and preserved as museum specimens in S_2 building.

CHAPTER-4
RESULTS

4.1 Captive breeding species

The following four species of butterflies namely: *D. chrysippus, Papilio demoleus*, *P. polytes* and *G. agamemnon* (Figure 6) were captive bred in the laboratory of MFU (Table 1).

Table 1. Captive breeding species of butterflies reared in the laboratory

Species	**Family**	**Common name**	**Location**	**Seasonal**
Danaus chrysippus	Nyphalidae	Plain tiger	MFU, Chiang Rai, Nan provinces	All round the year
Papilio demoleus	Papilionae	Lime Butterfly	MFU, Chiang Rai, Nan provinces	May-Sept.
P. polytes polytes	Papilionae	Common mormon	MFU, Chiang Rai, Nan provinces	May-Sept.
Graphium agamemnon	Papilionae	Tailed jay	MFU, Chiang Rai, Nan provinces	Jan-Feb

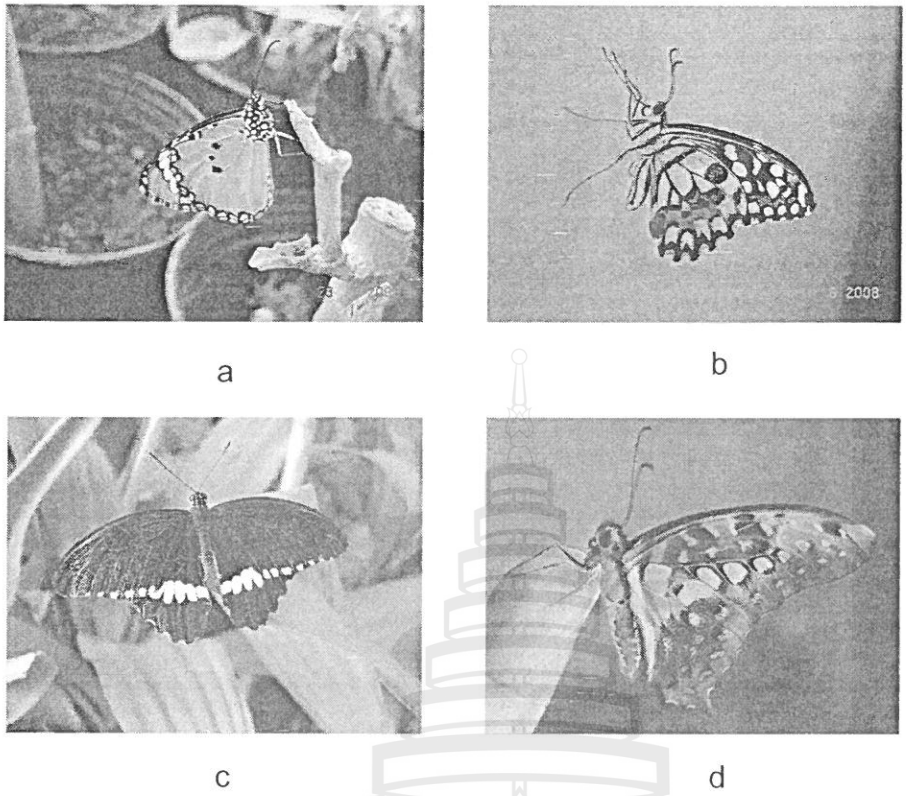


Figure 6. Captive breeding of butterflies in the laboratory. (a) *D. chrysippus*, (b) *P. demoleus* (c) *P. polytes*, and (d) *G. agamemnon*

4.2 Life cycle of butterfly

The life cycle of *D. chrysippus* was studied in the laboratory. The three other species of butterflies were not studied. Adult butterflies were had lifespan for 35-60 days under the natural condition. Egg stage was 3-5 days, larvae period 14-16 days and pupal stage 8-9 days.

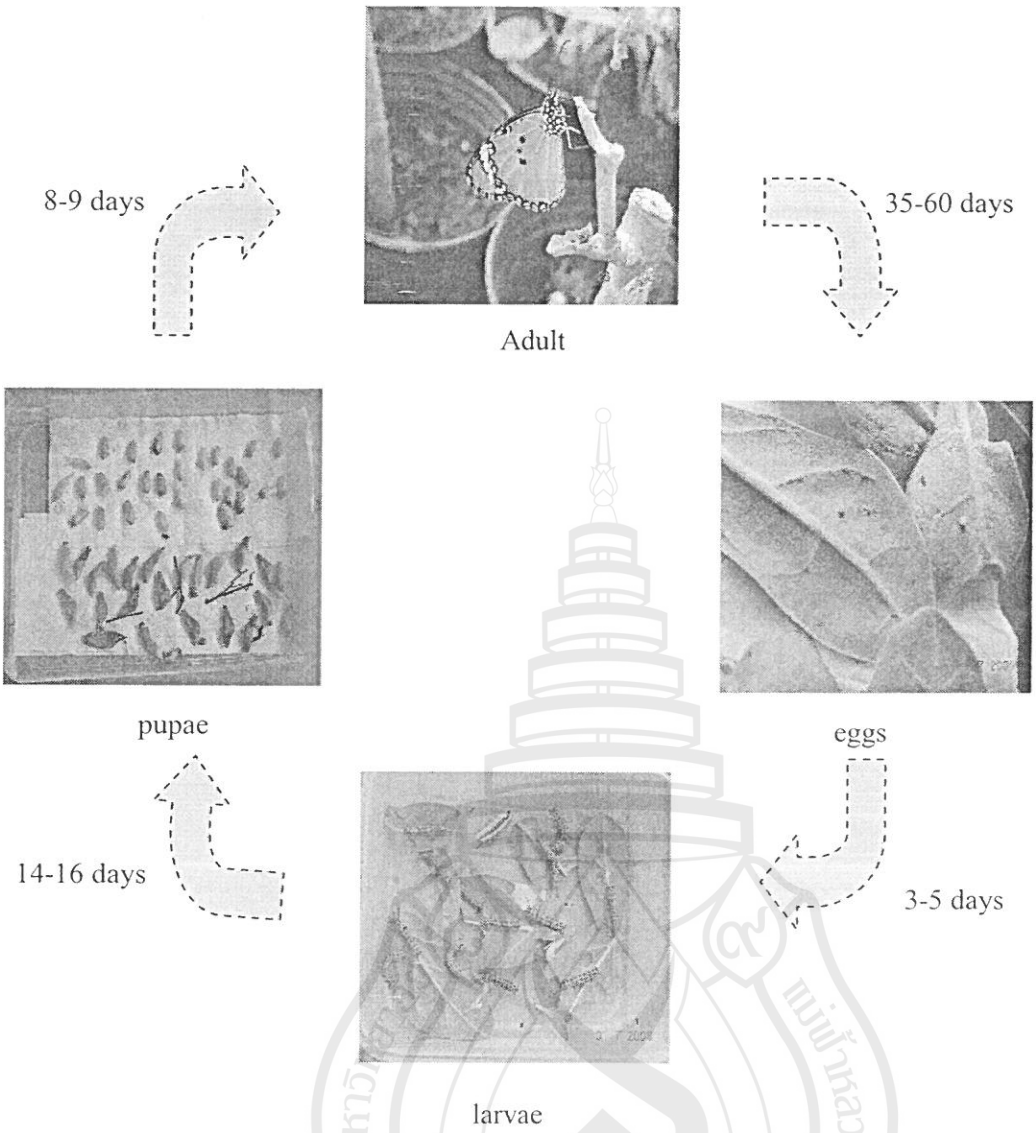


Figure 7. Lifecycle of *D. chrysippus*

4.3 Host plants

Three species of host plant were found around Mae Fah Luang University (Table 2). *Asclepias* sp. is bloom all around the year. *Citrus reticulate* was a seasonal.

Table 2. Host plants of captive breeding butterfly larvae.

Common name	Family	Scientific name	Location	Altitude	Season
Milkweed	Asclepiadaceae	*Asclepias* sp.	MFU, Nan, Chiang Mai	Above 350 m less than 800 m	All around the year
Tangerine, or Mandarin	Rutaceae	*Citrus reticulata* Blanco	MFU, Chiang Rai, Fang	Between 650-900m	June-July
-	-	-	Around MFU area		April-Sept.

4.4 Observation of butterflies

D. chrysippus was observed all around the year. *P. demoleus* was observed from March to July, *P. polytes* from mid of May to August, *G. Agamemnon* February to June, *T. limniace* from February to mid of August and *G. narina* from January to mid of March (Table 3).

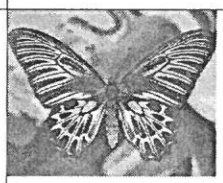
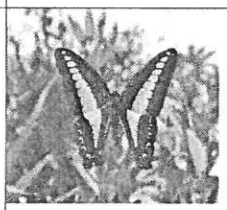
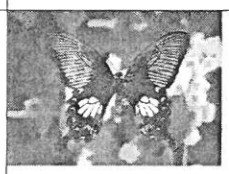
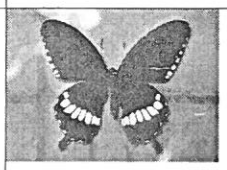
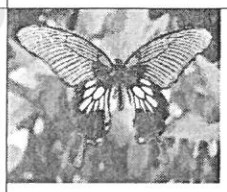
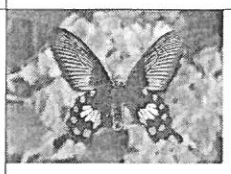
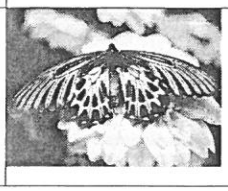
Table 3. Observation of butterflies in the field.

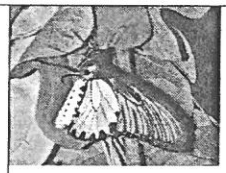
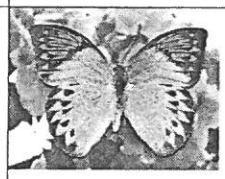
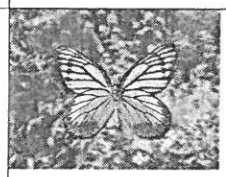
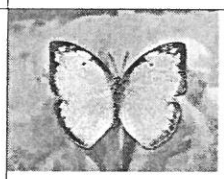
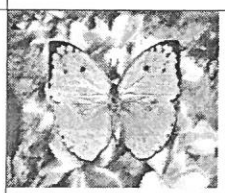
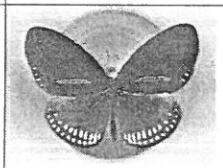
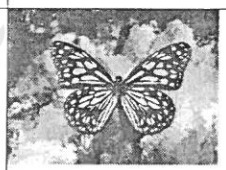
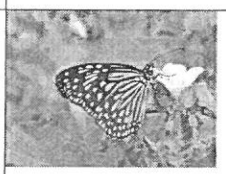
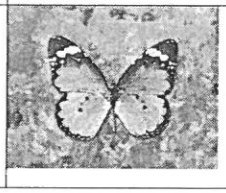
Butterfly species	Months of observation											
	J	F	M	A	M	J	J	A	S	O	N	D
D. chrysippus												
P. demoleus												
P. polytes polytes												
G. agamemnon												
T. limniace												
G. narina												

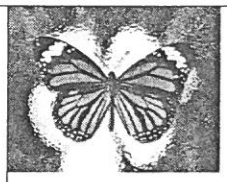
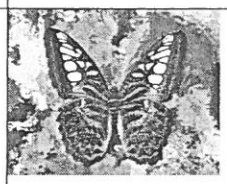
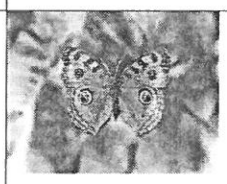
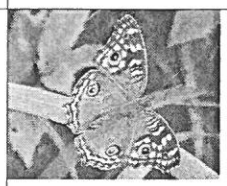
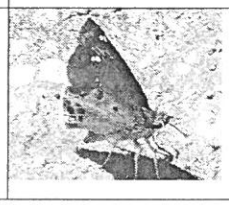
4.5 Checklist of Mae Fah Luang University butterflies

Twenty three species of butterflies were observed in Mae Fah Luang University (Table 4). Most of these butterflies were seasonal.

Table 4. Checklist of Mae Fah Luang University butterflies.

S. No	Family	Species	Common name	Sex	Phynotypes
1	Papilionidae	*Troides aeacus thomsoni*	The Golden Birdwing	Female	
2	Papilionidae	*Graphium sarpedon sarpedon (luctatius)*	The Common Bluebottle	Male	
3	Papilionidae	*Papilio polytes romulus* f-polytes	The Common Moron	Female	
4	Papilionidae	*Papilio polytes romulus*	The Common Moron	Male	
5	Papilionidae	*Papilio memnon agenor* f-distantianus	The Great Moron	Female	
6	Papilionidae	*Atrophaneura aristolochiae goniopeltis*	The Common Rose	Male	
7	Papilionidae	*Troides aeacus thomsoni (malailanus)*	The Golden Birdwing	Female	

8	Papilionidae	*Troides aeacus thomsoni (malailanus)*	The Golden Birdwing	Male	
9	Pieridae	*Hebomoia glaucippe glaucippe*	The Great Orange Tip	Female	
10	Pieridae	*Delias hyparete indica*	The Painted Jezebel	Male	
11	Pieridae	*Catopsilia pomona pomona*	The Lemon Emigrant	Male	
12	Pieridae	*Catopsilia pomona pomona*	The Lemon Emigrant	Female	
13	Nymphalidae (Subfamily : Danai)	*Euploea algea menetriesii*	The Long-Branded Blue Crow	Male	
14	Nymphalidae (Subfamily : Danainae)	*Tirumara limniace limniace*	The Blue Glassy Tiger	Female	
15	Nymphalidae (Subfamily : Danainae)	*Parantica agleoides agleoides*	The Dark Glassy Tiger	Male	
16	Nymphalidae (Subfamily : Danainae)	*Danaus chrysippus chrysippus*	The Plain Tiger	Female	

17	Nymphalidae (Subfamily : Danainae)	*Danaus genutia genutia*	The Common Tiger	Male	
18	Nymphalidae (Subfamily : Nymphalinae)	*Parthenos sylvia gambrisius*	The Clipper	Female	
19	Nymphalidae (Subfamily : Nymphalinae)	*Precis (Junonia) almana almana*	The Peacock Pansy	Female	
20	Nymphalidae	*Precis lemonias lemonias*	The Lemon Pansy	Female	
21	Hesperiidae	*Odontoptilum angulatum angulatum*	The Chestnut Angle	Male	

CHAPTER-5
DISCUSSION

The results show that *D. chrysippus* (Family: Nyphalidae) can breed in the laboratory all round the year. The others four speceis; *P. demoleus*, *P. polytes*, *G. agamemnon*, *T. limniace* and *G. narina* can breed in the laboratory only in the season. Because, the host plants (food) are not available during off the season. Therefore, the results suggest that *D. chrysippus* can be an excellent speceis for captive breeding as well as for display speceis. All these species is commonly available in the northern parts such as Chiang Rai, Chiang Mai, Nan, Phrae provinces including others adjoining provinces.

The results show that adult *D. chrysippus* can live up to 30 days. The life span of *D. chrysippus* compare to other three speceis viz; *P. demoleus*, *P. polytes*, and *G. agamemnon* was longer. This species is good for display species in the butterfly garden.

The results suggest that *Asclepias* sp. (milkweed) is produce the leaves all around the year. Therefore, *D. chrysippus* larvae are found all round the year. *Asclepias* sp. is wildly found all over the northern parts of Thailand. However, *C. reticulate* is a seasonal. The larvae feed on this plants are seasonal.

The result show that *D. chrysippus* is equivalent to Monarch butterfly a best captive breeding species for butterfly farm. The others three species are seasonal and these three species can not be captive breeding species for butterfly farm.

The results show that Mae Fah Luang University has 22 speceis of butterflies. The family: Papilionidae had 9 species; *T. aeacus*, *G. sarpedon*, *P. polytes*, *P. polytes*, *P. memnon*, *A. aristolochiae*, *T. aeacus* and *T. aeacus*. The family P ieridae had 4 species, *H. glaucippe*, *D. hyparete*, *C. pomona* and *C. pomona*. The family Nymphalidae had 8 species, *E. algea*, *T. limniace*, *P. agleoides*, *D. chrysippus*, *D. genutia*, *P. sylvia*, *P. almana*, and *P. lemonias*. Finally, the family Hesperiidae had one species, *Odontoptilum angulatum* which is the highest species of butterflies in

MFU compare to other areas in northern Thailand. Therefore, Doi Nygem should list under conservation of butterfly species area. Doi Nygem should be

CHAPTER-6
CONCLUSION

Four species of butterflies can be captive breeding in the laboratory. One species out of four captive breeding species can be reared around the year. There are around 22 speceis of butterflies are available around the Mae Fah Luang University. Doi Ngyem is the one of the most protective area for breed of bird wing butterflies. This species has been already listed as an endanger species in RED Book of IUCN.

CHAPTER-7
RECOMMENDATIONS

7.1 Butterfly breeding center

Two butterfly nurseries should be established to rear the butterflies under the natural conditions. In this butterfly garden, nectar plants for adult butterflies and host plants for larvae will be planted. Expected production of butterflies will be around 500 butterflies per month.

7.2 Butterfly house

Butterfly house should be constructed at Mae Fah Luang University. The size of the butterfly cage will be 120 meter long, 80 meter wide and 8 meter height. Students and visits can see the live butterflies over their head, and will promote the ecotourism at Doi Nygem, Mae Fah Luang University.

7.3 Museum specimens

The dead specimens of butterflies from breeding cage and butterfly house should be preserved in entomologist boxes. The museum specimens will be displayed to students and visitors.

REFERENCES

Brehm, G., Homeire, J., Fiedler, K. (2003). Beta diversity of geometrid moths (Lepidoptera: Geomtridae) in an Andean montane forest. *Biodiversity Research* 9: 351-366

Chen, I. C., Shiu, H. J., Benedick, S., Holloway J. D, Chey, V. Barlow K., H. S., Hill J. K., Thomas, C. D. (2009) Elevation increases in moth assemblages over 42 years on a tropical mountain. Proceedings of the National Academy of Sciences USA 106: 1479-1483.

Collins, N. M., Thomas, J. A. (1989). The conservation of insects and their habitats, Academic Press, London. pp. 412-417.

Erhardt, A. (1985) Diurnal Lepidoptera: Sensitive indicators of cultivated and abandoned grassland. *Journal of Applied Ecology* 22, 849-861.

Gardner, T. A., J. Barlow, I. S. Araujo, T. C. Avila-Pires, A. B. Bona ldo, J. E. Costa, M. C. Esposi to, L. V. Ferreira, J. Hawes, M. I. M. Hernand ez, M. S. Hoogmoed, R. N. Leite, N. F. Lo-Man -Hun g, J. R. Malcolm, M. B. Martins , L. A. M. Mestre, R. Miranda -San tos, W. L. Overal, L. Parry, S. L. Peters, M. A. Rib eiro-Juni or, M. N. F. da Silva, C. da Silva Motta & C. A. Peres. 2008. The cost-effectiveness of biodiversity surveys in tropical forests. Ecology Letters 11:139-150.

Ghaz oul, J. (2002). Impact of logging on the richness and diversity of forest Butterflies in a tropical dry forest in Thailand. Biodiversity and Conservation 11: 521–541.

Hill, J. K., Hamer, K. C., Tangah, J., Dawood, M. (2001). Ecology of tropical butterflies in rainforest gaps. *Oecologia* 9: 294-302.

Koh, L. P., Sodhi, N. S. (2004). Importance of reserves, fragments, and parks for butterfly conservation in a tropical urban landscape. Ecological Applications 14: 1695-1708.

Kremen, C. (1992) Assessing the indicator properties of species assemblages for natural area monitoring. *Ecological Application* 2: 203-217.

Pearson, D. L. (1994). Selecting indicator taxa for the quantitative assessment of biodiversity. Philosophical Transactions of the Royal Society of London Series, *Biological Sciences* 5: 75-79

Thomas , C. D. (1991). Habitat use and geographic ranges of butterflies from the wet lowlands of Costa Rica. Biological Conservation 55: 269-281.

Vane-Wright, R. I., Ackery, P. R. (1984). The Biology of Butterflies. Academic Press, London.