Bryophyte, pteridophyte and orchid diversity in the cloud forest of Khao Nan, Nakhon Si Thammarat Province

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The diversities of bryophytes, pteridophytes and orchids were explored from July 2007 to June 2008 from elevations above 600 m to the summit of Khao Nan Yai, Khao Nom and Sunyen in the Khao Nan area. A total of 1,279 specimens were collected from these focal sites. They were determined and classified into: 50 families, 131 genera, 264 species of bryophytes; 25 families, 66 genera, and 163 species of ferns and fern allies; and 41 genera, and 91 species of orchids. Among these, about 20 species may be new bryophyte records, two species, namely *Cyathea glabra* (Blume) Copel. and *C. hymenodes* Mett., are new records of ferns and 1 species, namely *Calanthe angustifolia* (Blume) Lindl. var. *flava* Ridl., is an orchid new record. It was seen that the cloud forest of Khao Nan houses up to 518 species of these nonvascular and vascular plants. Some of them are rare. It is noted that epiphytes are richer in number of species than terrestrials, probably due to the more suitable environment for plant growth in the cloud forest. These epiphytes seem to be good indicators for undisturbed hill evergreen forest. Implications for understanding global warming in tropical areas are discussed.

Diversity of pteridophytes in the cloud forest of the Khao Nan area, Nakhon Si Thammarat Province

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The diversity of pteridophytes was investigated from July 2007 to April 2008 at elevations above 600 m at Khao Nan Yai, Khao Nom and Sunyen in the Khao Nan area. Four hundred and forty-six specimens were collected and were determined into 25 families, 66 genera, and 163 species. Among these, 3 families, 5 genera and 12 species were fern allies, while 22 families, 61 genera, and 151 species were ferns. It is noted that epiphytes were richer in number of species than terrestrials, probably due to the more suitable environment for pteridophyte growth in the cloud forest. It was found that the fern family Grammitidaceae was observed only at altitudes above 900 m. Some members of the Hymenophyllaceae and Polypodiaceae also occurred near the mountain summit at about 1,300 m altitude. These ferns tend to be good indicators of undisturbed hill evergreen forest. The cloud forest of Khao Nan also housed rare plants that are on the Thailand Red Data list, i.e. *Xiphopteris khaoluangensis*, *Crypsinus laciniatus*, *Dipteris conjugata* and *Tapeinidium luzonicum*. In addition, a species of *Lycopodiella* new to science was found and will be published in the near future. It is expected that new data of pteridophyte diversity gained from this study will be useful for future management of the Khao Nan area.

Diversity of bryophytes in Khao Nan National Park, Nakhon Si Thammarat Province

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Exploration for bryophytes at Khao Nan National Park, Nakhon Si Thammarat Province, was conducted at 600 - 1438 m above mean sea level, from July 2007 to June 2008. A total number of 671 specimens of bryophytes were collected from this focal site. All specimens were identified and kept in the Kasin Suvatabhandhu Herbarium (BCU), Department of Botany, Faculty of Science, Chulalongkorn University. They were classified into 3 classes: Musci (mosses) with 24 Families, 66 Genera, 151 species; Hepaticae (liverworts) with 25 families, 64 genera, 112 species; and Anthocerotae (hornwort) with 1 species, namely *Dendroceros subplanus* Steph. Among these bryophytes, more than 20 species are reported as new records for Thailand. Furthermore, more than 50 species were undetermined. They apparently require further observations and investigation to determine their correct status. The distribution and abundance of bryophytes along each study trail suggests that Khao Nan National Park harbors a high diversity of bryophytes.

Diversity of orchids at high altitude in Khao Nan National Park, Nakhon Si Thammarat Province

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Field exploration and data collection for natural orchids were conducted at 600-1,438 m above sea level at Khao Nan National Park from July 2007 to June 2008. A total of 132 specimens of orchids were collected from this focal site. All specimens were identified and kept at the Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University. They were classified into 41 genera and 91 species. The most common genus, *Bulbophyllum*, had the highest number of species among orchids, i.e. 8. The other common genera found in the area were *Dendrobium*, *Calanthe* and *Coelogyne* (7, 6 and 6 species, respectively). According to habitat types, the specimens can be classified into 3 groups: terrestrial plants (29 species including 6 saprophytes), epiphytes (61 species), and lithophytes (1 species). One orchid was a newly recorded species for Thailand, i.e. *Calanthe angustifolia* (Bl.) Lindl. var. *flava*. Three endemic species of Thailand were found in the area, *Ceratostylis thailandica* Seidenf., *Bulbophyllum smitinandii* Seidenf. & Thorat and *Bulbophyllum* cf. *ovatum* Seidenf. The common species in Khao Nan National Park included *Coelogyne massangeana* Rchb.f., *Pholidota carnea* (Bl.) Lindl., and *Calanthe triplicata* (Willemet) Ames. There were 8 undetermined species apparently requiring further observations and investigation to determine their correct status. They were classified into the genera *Appendicula*, *Coelogyne*, *Dendrobium*, *Liparis*, *Oberonia*, *Pomatocalpa*, and *Taeniophyllum.* Moreover, 11 species are listed as threatened and 17 species are listed in the CITES database. These species were of endangered status and must be protected and conserved.

Species diversity and phenology of fig trees (*Ficus* ssp.) and their relationships to frugivore species diversity in Khao Nan National Park

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This research focuses on two main issues concerning the species diversity of fig trees, species richness and species abundance, and whether they can fulfill their ecological roles to serve local wildlife for successful survival. Habitat suitability for fig trees was also studied in detail. The results revealed 50 fig species, which was equivalent to 50% of species of the whole country. Species abundance varied from moderately common to very common. The majority of species were distributed throughout the study area, except for *Ficus ischnopoda* Miq. and *Ficus obpyramidata* King which kept to the waterways only. A phenological study concentrated on the fruiting of 7 representative species. It was found that all species tend to bear fruits all year round. 25 species of frugivores were recorded; among them the mammals seemed to prefer terrestrial figs to banyans, while the birds were opposite in their preferences.

Effect of habitat type on ground-dwelling ant diversity at Khao Nan National Park, Nakhon Si Thammarat

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Khao Nan National Park (KNNP) is located in Nakhon Si Thammarat Province. The national park consists of many different forest types. As a consequence, floral and fauna are very diverse. Ants play an important role in the ecosystem. However, there is little information about ants in the national park. The aim of this study was to determine the effect of habitat type on diversity of ground-dwelling ants in KNNP. Three study sites (Baucheak, Pra Forest, and the Sunantha trail) were chosen, each with three permanent plots of 30x30 m at least 500 m apart. Five different methods were used for ant sampling: honey bait (HB), leaf litter sampling (LL), hand collection (HC), pitfall trap (PT), and Winkler Bag (WB). Samples were taken every two months from January 2006-January 2007. 245 species from 50 genera of ants were detected. These were further classified into 10 subfamilies: Myrmicinae (109), Formicinae (55), Ponerinae (46), Dolichoderinae (15), Cerapachyinae (4), Pseudomyrmecinae (6), Aenicitinae (4), Dorylinae (3), Ectatomminae (2) and Amblyoponinae (1). The dominant genus of ants was *Pheidole* (31) followed by *Camponotus* (20). Each sampling method produced a different dominant species. Detrended Correspondence Analysis (DCA) showed that there was a distinct difference between the ants present at the Baucheak and Pra Forest sites.

Species composition of canopy ants (Hymenoptera: Formicidae) in tropical rainforest at Khao Nan National Park, Nakhon Si Thammarat Province

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This study is a year-round investigation of the species composition of ants present in the canopy of the tropical rainforest at Khao Nan National Park (KNNP), Nakhon Si Thammarat Province, Southern Thailand, from May 2006-March 2007. Two habitat types were chosen, one located at the headquarters of KNNP represented by evergreen trees and the other at Hui Lek station where there is a stand of the briefly-deciduous tree, *E. tapos*. Each habitat contained three permanent plots of 50 X 50 m^2 established 500 m apart from each other. A chemical knockdown by fogging technique was applied to collect ant samples. In each plot, a single tree was arbitrarily selected for fogging at bimonthly intervals. Overall, 16,884 individual ants were identified, belonging to 7 subfamilies, 34 genera and 210 morphospecies. Ants in the subfamily Myrmicinae and Formicinae were the dominant species followed by Dolichoderinae, Pseudomyrmicinae and Ponerinae, Anictinae, and Cerapachyinae. In terms of abundance of species, the top five genera were *Crematogaster*, *Camponotus*, *Polyrhachis*, *Pheidole*, and *Technomyrmex* whereas *Dolichoderus thoracicus*, *Oecophylla smaragdina*, *Dolichoderus* sp.4, *Dolichoderus* sp.5, and *Crematogaster (Paracrema)* sp.2 were dominant in terms of numbers of individuals.

Diversity of Olethreutine moths (Lepidoptera: Tortricidae) in Khao Nan National Park, Nakhon Si Thammarat Province

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Surveys and collections of Olethreutine moths in Khao Nan National Park were carried out from November 2007 to October 2008 at various sites in evergreen forest. A total of 380 specimens were collected using blacklight and mercury vapor lights on 60 nights. They were determined into 167 morphotypes within 7 tribes, namely Microcorsini, Gatesclarkeanini, Bactrini, Olethreutini, Enarmoniini, Eucosmini and Grapholitini. Of these, 16 species in 13 genera were identified. The survey also included 54 morphotypes that could be identified to 25 genera, but not to species level. Furthermore, ninety-seven morphotypes could not be placed into any known genus or species. The genera *Anthozela* and *Irianassa* are recognized as new genus records for Thailand.

Species diversity of butterflies in Khao Nan National Park, Nakhon Si Thammarat Province

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The species diversity of butterflies was investigated at Khao Nan National Park, Nakhon Si Thammarat province, by employing 2 conventional data collecting techniques, i.e., a 1-km line-transect and live trapping. The study was done every alternate month for 1 year, starting from late 2006 to late 2007. A total of 307 species of butterflies occurred in the area. They were classified into 5 families and 158 genera, of which 31 species were in the family Papilionidae, 25 in the family Pieridae, 121 in the family Nymphalidae, 78 in the family Lycaenidae, and 52 in the family Hesperiidae. Among these, 71 species were endemic to the south, and 1 was an alien species, the Julia. One, the Sumatran Gem (*Poritia sumatrae*), was found to be distinctive enough to be a new subspecies. Regarding species abundance, it was found that 154 species were very common, 120 were moderately common and 33 were rare. The preferred habitat as expressed by the decreasing value of diversity was lowland moist evergreen forest with H=4.456, secondary forest with streams with H=4.339; moist evergreen forest without streams with H=3.964. Regarding habitat similarity, the highest value was found between the lowland moist evergreen forest with streams and the secondary forest with streams, while the lowest value was between the secondary forest with streams and the moist evergreen forest without streams. This study also confirmed the existence of 3 legally protected butterflies, i.e., the Malayan Birdwing, Common Birdwing and Banded Peacock, all classified in the family Papilionidae; the first two are also declared insect species in the CITES Appendix II list.

Biodiversity and ecology of amphibians in the cloud forest of Khao Nan National Park

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An amphibian survey was carried out in Khao Nan National Park, Nakhon Si Thammarat Province, Thailand, between April 2006 and May 2007, and documented 31 species. Almost all amphibians inhabited stream ecosystems of the moist evergreen forest, hill evergreen forest and limestone caves. Various niches were recorded, such as aquatic, terrestrial. fossorial and aboreal. Records of species for this area comprised 2 orders (Anura and Gymnophiona) and 7 families, namely Ichthyophiidae, Megophryidae, Bufonidae, Microhylidae, Dicroglossidae, Rhacophoridae and Ranidae. Interesting species included *Brachytarsophrys carinensis, Xenophrys* spp., *Ansonia* sp., *Ingerana* sp. and *Limnonectes* sp. which need further studies.

Effect of climate change on cloud forest at Khao Nan, Nakhon Si Thammarat

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Cloud forest has a high incidence of low level cloud cover resulting in high relative humidity and low solar radiation. This research investigated climatic characteristics of the Khao Nan cloud forest ecosystem by developing a cloud forest habitat characterization model and simulating how climate change affects this cloud forest by varying climatic parameters. The process utilized real biological and geographical data from Khao Nan cloud forest from automatic weather stations and temperature/relative humidity data loggers. Programs for analyzing data were developed for this study. The programs included a statistics program, interpolation module, area-based interpolation module, data visualization, and area-based data visualization. We installed three automatic weather stations and eight data loggers around Khao Nan National Park. Data correction for sensors' battery problem and data visualization programming were done. More sensor installation and data analysis programming were done. A better understanding of how climatic factors affect cloud forest characteristics and boundaries helps in management and conservation of this forest ecosystem, which is considered a unique ecological community and an important source of endemic species.

Ecological characteristics of the tropical montane cloud forests of Khao Nan

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Cloud forest characteristics in the tropical montane cloud forest of Khao Nan, Nakhon Si Thammarat, were studied from 18-21 April 2007 with regard to climate, vegetation, soil and hydrology. An automatic weather station was installed on Doen Hok peak at 1053 m a.s.l. in March 2007 for collecting climate data. The results showed that as air temperature of the Sanyen cloud forest increased, the percent relative humidity decreased. The mean, minimum and maximum temperatures were 20.1, 17.4 and 24.1 °C, respectively. The amount of solar radiation at Sanyen cloud forest was very low with a range of 0-19 W/m^2. There were no differences among leaf widths, leaf lengths, leaf thicknesses and leaf areas of some plants with increasing elevation. As the elevation increased, bush height and tree height decreased. There were no associations of bush width and bush ratio with elevation. As elevation increased, the percent epiphyte cover and the percent soil moisture increased but water temperature, conductivity, and dissolved oxygen decreased. Percent soil moistures and organic contents were higher at elevations above 900 m than at elevations below. The mean, minimum and maximum temperatures of Doen Hok cloud forest automatic weather station from March 2007 to March 2008 were 19.5, 15.2 and 27.9 °C, respectively, with an average relative humidity of 96.1%.

A great cultural diversity in the Khao Nan Area

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Khao Nan is a mountain located in Nobphitum sub-district in Nakhon Si Thammarat Province. This area is surrounded by rich natural resources, of soil, rivers, forest, and various wildlife, which provide a high quality of life for people and contributes to the sustainable living of the people who utilize these resources.

The community of people in the Khao Nan area comprises various races and nations. Native people settled in this area for 800 years before Nakhon Si Thammarat was named. Some people came from other parts of Thailand, and some are of mixed racial parentages or descendants of other ethnic groups. These people inherited their own historical culture. However, until now, some cultures have become less important, some cultures have changed from their original cultures because of the influence of other cultures, and some cultures have been created from the local intelligence of community members.

The traditional characteristics of the Khao Nan people are related to human living. Most traditions are involved in the moral goodness of many religions especially Buddhism which support the happiness of both the individual and society. Regarding health care culture, patient treatment is still by using herbs together with psychotherapy through traditional rites. In terms of occupation, many types of work are found in this area, such as fishing, hunting and, exceptionally, driving bees out of nests, because of the fertility of the Khao Nan area. Presently, beliefs regarding supernatural things and superstition still remain.

The cultural diversity of Khao Nan's people results from natural conditions that affect their feelings and from combinations of experiences among individuals and groups. The majority of cultures are similar to Nakhon Si Thammarat Culture because of common descendants and mixing with neighbors. The existence of great cultural diversity in the Khao Nan area provides the high quality of their lives.

Evaluation of the use of *Eltaeriospermum tapos* forest: A case study of Nopphitam District, Nakhon Si Thammarat Province

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The objectives of this study were to evaluate the use of *Eltaeriospermum tapos* forest using the market valuation method and to assess the willingness to pay an entrance fee to use the forest using the Contingent Valuation Method (CVM). 252 respondents were randomly selected and interviewed from 4 villages in Tumbon Krumgching (Khao Nan National Park, Nopphitam District, Nakhon Si Thammarat Province). In the market valuation method, the use value of the forest could be estimated by the product of the price and quantity of non-timber forest products utilized by households. The results showed that in 2007 the use value of the forest, both for household consumption and trade, was 1,593,783.62 baht (or 6,324.56 baht per household). The closed-ended, single-bounded Contingent Valuation Method was used to estimate the community's willingness to pay an entrance fee to the *Eltaeriospermum tapos* forest. The results found that the mean willingness to pay for an entrance fee was 18.30 baht per person per day.

A preliminary study on socio-economics and relationships between communities and biodiversity for strategy development in collaborative biodiversity management: A case study of Khao Nan National Park, Nakhon Si Thammarat

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There are 27 communities surrounding Khao Nan National Park, ranging from 30 to 100 years of settlement. Communities were mostly established during the mine and forest concession periods. The main livelihoods now are Para rubber plantations, and fruit orchards. The religion is Buddhism, while people also maintain Nakhon Si Thammarat traditional culture. Forest dependence of the communities consists of water for orchards and for household consumption, as well as catching fresh water animals. Khao Nan National Park is the main watershed area providing ecosystem services through more than a hundred stream flows. Furthermore, communities derive non-timber products, e.g., wild plants and vegetables for food. The forest also provides important sources of income, especially 'Prah' or *Eltaeriospermum tapos* fruits. Khao Nan National Park has the biggest site for 'Prah' in Thailand covering 4,000-5,000 rai near Huai Lek Park Protection Unit and near Huai Tong and Tup Nam Tao villages. A quantitative study of the two villages showed that 97,036 kg of 'Prah' were collected during 20 August - 20 September 2007, with an average of 3.2 tons per day, and a total economic value of 1,259,550 Baht. This indicates that average financial flow within these two villages is 41,238 Baht per day and the average number of collectors per day is 117 people. Furthermore, the forest has important roles in local tradition, culture, nature tourism and maintaining local biodiversity, watershed ecosystem and wildlife habitats.