

## The Vegetation of the Catba National Park in Vietnam

Kim, Jong-Won\* and Nguyen Nghla Thin

Keimyung University, Taegu 704-791, Korea\*

Vietnam National University, Hanoi Vietnam

### 베트남 캣바국립공원의 식생

김종원\* · Nguyen Nghla Thin

계명대학교 자연과학대학 생물학과\*, 하노이 베트남국립대학

#### ABSTRACT

The Catba national park (20°42'~20°54'N, 106°54'~107°09'E), which is a representative protected area in northeast Vietnam, was first investigated in terms of phytosociology of the Zürich-Montpellier School. 15 plant communities were identified from the seven vegetation types: *Teetaria-Amoora gigantea* community, *Blechnum-Pitecellobium ferrugineum* community, *Impatiens-Dracaena cambodiana* community, *Rhizophora apiculata* community, *Avicenia marina* community, *Panicum repens* community, *Heterosmilax-Zanthoxylum nitidum* community, *Stachytarphyta jamaicensis-Bidens bipinnata* community, *Microstegium vagans* community, *Dicranopteris linearis* community, *Randina-Sapium sebiferum* community, *Psidium gujava* community, *Elephantopus scaber* community, and *Chirita aratiformis* community. Traditional pasturing and shifting agriculture by indigenous people in Catba national park were recognized as main disturbance regimes, which have been far above sustainable levels. Ecological strategies for conservation and sustainable use on national park's ecosystem were proposed: (1) development of awareness program on sustainable life style of indigenous people, (2) establishment of multiple use module system of national park, (3) ecosystem monitoring of permanent ecological sites.

*Key words*: Catba national park, Limestone vegetation, Phytosociology, Tropical monsoon, Vietnam.

#### INTRODUCTION

Vietnam's ecosystems have been lost at an almost whole land cover as forest areas were destroyed during 1970's war. A relict natural vegetation is restricted within the protected areas and currently converted to other uses (Thin 1994). The Catba national park is one of representative protected areas in Vietnam where contains some few natural ecosystems.

The Catba national park is situated at the Catba islands of Halong Bay in northeast Vietnam. This region is characterized as a tropical monsoon humid and limestone area (Ministry of Forest 1992). There are no phytosociological data reported from the region.

Present paper gives the results of vegetation classification in terms of Zürich-Montpellier School. This research strategy is advocated in areas where the ecological investigations are still at an explorative stage

(Müller-Dombois and Ellenberg 1974). Plant communities classified from the Catba national park were described by synecology of habitat condition, structural characteristics and geographical distribution of species and phytocoenosis. On the other hand, the national park's area has been greatly interfered by indigenous people (Thin and Harder 1996). Particularly, salt marshes once covered by mangrove vegetation were almost converted into shrimp culture (Santisak 1983, Scott 1989). After diagnosing preliminarily various disturbance regimes, the ecological strategy for sustainable use of park's area is proposed on the basis of present research.

### STUDY AREA

The Catba national park is situated at the Catba islands about 48 km remote from Hai Phong city in Halong Bay and comprises of a group of off-shore

islands in 20°42'~20°54'N, 106°54'~107°09'E. It has an overall area of 27,000 ha (Fig 1). The relief therein is carved with calcareous rocky mountains from 5 to 200 m above sea level. The highest Cao



Fig. 2. A typical landscape of the Catba National Park.

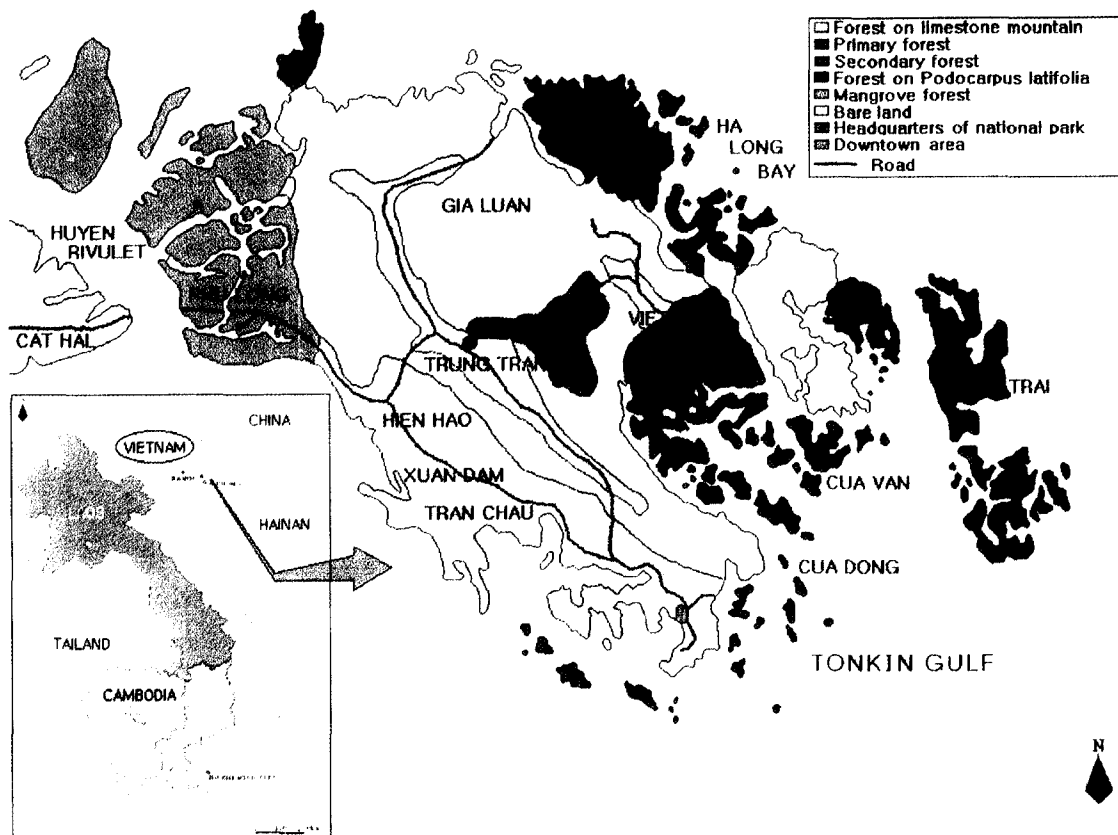


Fig. 1. Geography and vegetation map of study area (slightly modified from anonymous material).

Vong peak reaches merely 322 m a.s.l., 10% of the island is below 50 m altitude, however some places of the main island as Ang Tom in Viet Hai Village are below sea level. There are many narrow passes such as Dalat, Eo Bua, Kham Cao and well-sheltered valleys such as Trung Trang, Gia Ruan. Most of the rainwater flows into the caves and grottos and follows underground streams to the sea. Therefore some parts of the areas experience an acute water shortage of water during the dry season (Fig. 2).

Only a few meteorological data sets are available from Catba national park. Climate of the Catba National Park is characterized as a tropical monsoon with pronounced wet and dry season. The mean annual temperature at sea level is 25°C to 28°C and goes up 30°C in the summer season. The mean annual rainfall is 1,700 mm to 1,800 mm. The rainy season lasts from May to September, the heaviest rainfall occurring in July and August. The mean annual relative humidity is 85%. There is often some drizzle during January to March (Scott 1989, Ministry of Forest 1992). The prevailing wind is southeastern and tropical storms are frequent. The dry and cold season last from November to March. In the Catba national park there are the following main soil types which are developed from limestone, granite and sandstone: black soil on slope covered with forest, brown soil developed from recent alluvium found on lower slopes and in valleys covered with big trees, clay soil found in flats and seasonal swamp along springs and in waterlogged area, ferallitic soils with deep layers on which a wide range of forest trees can thrive, muddy soils found in swamp mangrove and wetlands, and sand beaches and or rocky shores on which marine biota prosper.

## MATERIALS AND METHODS

After preliminary reconnaissance such as representativeness, homogeneity and suitability of research sites, the phytosociological relevés were subjectively randomly taken utilizing to the Zürich-Montpellier School's approach (Braun-Blanquet 1965, Westhoff

and van der Maarel 1973). Such a sampling strategy is advocated in areas where the ecological investigations are still at an explorative stage (Müller-Dombois and Ellenberg 1974). Most sites of relevés are located in the national park areas. Sixteen relevés comprising 96 species in 8 vegetation types were collected. Raw data was assorted by the classical block structure-seeking and hand sorting technique (Becking 1957, Braun-Blanquet 1965). Species was regarded as diagnostic when it was restricted to specific habitat types. In community tables (species × relevés), percent coverage of species was transformed into the van der Maarel's scale 0~9 (van der Maarel 1979). All plant communities classified were described by synecology of habitat condition, structural characteristics and geographical distribution of species and plant community. The nomenclatural solution for plant names was referred to the Ho (1992, 1993).

## RESULTS

### Tropical monsoon humid forests on limestone

#### 1. Primary forests

##### 1) *Teetaria-Amoora gigantea* community

There are three types such as the *Teetaria-Amoora gigantea* community on lower foot slopes and in valleys with a deep and humus-rich soil layer, the *Syzygium-Aquilaria* community on rocky slopes with shallow soils, and a wind-dry forest type on rocky at summit.

The *Teetaria-Amoora gigantea* community (Table 1) is a kind of primary forests on lower foot slopes and in valleys with a deep and humus-rich soil layer. Biomass of timber is 100~160 m<sup>3</sup>/ha. Five layers are clearly differentiated and buttress and caulifloras are common. Species composition is rather simple (25 species in 600 m<sup>2</sup>). This type is often codominated by Anacardiaceae (*Dracontomelum duperreanum*), Meliaceae (*Aglaiia gigantea*, *Chukrasia tabularis*), Euphorbiaceae (*Macaranga auriculata*), Lauraceae (*Caryodaphnopsis tonkinensis*, *Machilus* sp., *Cinnanonum* sp.),

**Table 1.** *Teetaria-Amoora gigantea* community of humid tropical forest type on deep soil in limestone area

---

Relevé No. : 27-1; Relevé site (date): Ang May Lau in Trung Trang Village Cat Ba District in Haiphong Province, Vietnam (July. 27. 1997); Altitude: 110 m; Exposition: SWW; Slope: 10°; Area: 600 m<sup>2</sup> (20 × 30); Topography: Upper slope; Microtopography: flat; Soil: Brown forest soil; Substrate: sandy loam; Mother stone: limestone; Human impact: medium. Height and coverage of tree layer-1: 30 m, 95%; Height and coverage of tree layer-2: 18 m, 40%; Height and coverage of shrub layer: 7 m, 85%; Height and coverage of herb layer: 2 m, 80%; Species composition: 25 spp.

---

Species of tree layer-1 : *Amoora gigantea* 6, *Engelhardia chrysolepis* 7, *Elaeocarpus dubius* 6, *Dracontomelum duperreanum* 6, *Castanopsis indica* 5,

Species of tree layer-2 : *Engelhardia chrysolepis* 6, *Castanopsis indica* 6, *Dillenia heterophylla* 6, *Elaeocarpus* sp. 6, *Mallotus paniculatus* 5, *Canarium album* 6, *Saraca dives* 5,

Species of shrub layer : *Dillenia heterophylla* 5, *Canarium album* 5, *Diospyros* sp. 6, *Wendlandia glabrata* 6, *Lindera* sp. 5, *Saraca dives* 5, *Caryota bacsonensis* 5,

Species list of herb layer : *Ardisia elegans*, *Bridelia balansae*, *Saurauja tristyla*, *Pterospermum heterophyllum*, *Teetaria decurrens*, *Aspidistra typica*, *Calamus* sp., *Ardisia silvestris*, *Bauhinia scandens*, *Dillenia heterophylla*, *Strobilanthes* sp. (*Acanthaceae*), *Macaranga auriculata*.

---

Bursaceae (*Canarium album*), Lythraceae (*Lagerstroemia calyculata*) in the first layer up to 25~30m high, the second layer (10~15 m) by *Elaeocarpus* spp. (*Elaeocarpaceae*), *Engelhardia chrysolepis* (*Juglandaceae*) *Deutzianthus tonkinensis* (*Euphorbiaceae*), *Spondias lakonensis*, *Choerospondias axillaris* (*Anacardiaceae*), *Markhamia stipularis* (*Bignoniaceae*) *Nephelium* sp. (*Sapindaceae*), the third layer of under-canopy (7~10 m) by tree saplings of two upper layers and other species which are able resistance under the shade such as *Streblus macrophyllus*, *S. ilicifolius*, *S. tonkinensis*, *Ficus hispida*, *F. glandulosa* (*Moraceae*), *Diospyros* spp. (*Ebenaceae*), *Phoebe pellida* (*Lauraceae*), *Meliusa balansae*, *M. filipes*, some other *Melius* sp. (*Annonaceae*), *Gironiera subaequalis* (*Ulmaceae*), *Saraca dives* (*Casalpinaceae*), *Garcinia bonil* (*Clusaceae*), the shrub layer (2~7 m) by species of *Rubiaceae*, *Urticaceae*, *Euphobiaceae*, *Cyathea* *ceae*, *Angiopteridaceae*, *Myrsinaceae*, and the ground layer (<2 m) by species of *Araceae*, *Urticaceae*, *Marantaceae*, *Rubiaceae*, *Balsaminaceae*, *Myrsinaceae*, *Arecaceae*, *Convallariaceae*, *Moraceae*. The off-layer plants are relatively abundant including many woody lianes such as genera *Strychnos*, *Bauhinia*, *Uncaria*, *Acacia*, *Aristolochia*, *Uvaria*, *Caesalpinia*, *Entada*, *Derris* and many epiphytes as *orchidaceae*, *Pteridophytes*, *Bryophytes*, *Araceae*, *Asclepiadaceae*, and also many Hemiparasites as *Chloranthaceae*, *Viscaceae*.

On the other hand, an evergreen forest type is found on rocky slopes with shallow soils. Main species in this type are able to adapt to dry and poor condition. The community structure also becomes simpler 3 layers, poorer species composition, and less biomass (ca. 70~80 m<sup>3</sup>/ha). The first layer (10~15 m) was dominated by *Syzygium* spp. (*Myrtaceae*), *Deutzianthus tonkinensis*, *Endospermum chinense* (*Euphorbiaceae*), *Spondias lakonensis* (*Anacardiaceae*), *Nephelium* sp. (*Sapindaceae*), *Castanopsis* sp., *Lithocarpus* sp. (*Fagaceae*), *Polyalthia* sp. (*Annonaceae*), *Caryota bacsonensis*. They grow sparsely and became towered. The second layer (6~10 m) was dominated by *Aquilaria crassna*, *Nephenium* sp., *Meliusa* spp., *Diospyros* spp., *Streblus macrophyllus*, *S. ilicifolius*, and the ground layer was very scattered by *Pteridophytes*, *Amorphophalus* spp. The lianas and epiphytes in this type are rare.

A wind-dry forest type on rocky at summit is characteristic by dry stunted trees of open canopy living in hot condition of strong wind. The vegetation height is not exceeding 5 m. Biomass of timber is 50 m<sup>3</sup>/ha. Community structure is very simple in two layers. The first layer consists of the species of *Sapindaceae*, *Aceraceae*, *Ebenaceae*, *Rutaceae* and the lower one of the genera *Dracaena*, *Clematis*, *Jasminum*, *Euphorbia*, *Bauhinia*, *Derris*, and *Sasa*.

## 2. Secondary forests

### 1) *Blechnum-Pitecellobium ferrugineum* community

Several types of secondary forests are found in the valleys or on slopes of the limestone hills near to the villages. Four types are found: the *Blechnum-Pitecellobium ferrugineum* community substituting the primary forests of *Teetaria-Amoora gigantea* community, a scrub vegetation on limestone, an inundated willow forest, and the *Podocarpus feuryi* forest.

The *Blechnum-Pitecellobium ferrugineum* community (Table 2) develops on lower foot slopes and in valleys exploited extensively by the local people for construction and firewood. Almost big trees of the upper layers were cut down and the biomass of timber reduced. Many shade-loving species of ground layer were quickly lost from above primary forests and some light-loving ones (e.g. species of Poaceae as Bamboo) were appeared.

The scrub vegetation on limestone is a secondary type changed strongly by impact of people. All forest trees were cut down and replaced by dry and light-loving shrubs which grow scatteringly. Characteristic species belong to Vacciniaceae, Myricaceae, Dracaenaceae, Euphorbiaceae, Fabaceae, Araliaceae, Balsaminaceae, Caesalpinaceae, Gesneriaceae, and Melastomataceae. The inundated forest type of the *Salix*

*tetrasperma* community is found at Ao Ech of 3.2 hectares. The stand density is 2500 trees per hectare, 13 cm in DBH and 12 m in height. The forest being under 0.5 m of water and inhabited by a wide range of wild life and birds. The species here have large system of roots and air-roots. Regeneration of this species is great by branch (7 shoots at foot of tree per each) and seed (10,000 seedlings/ha). Its biomass is 150~200 m<sup>3</sup>/ha (But 1989). The *Podocarpus feuryi* forests are secondary and found at Me con - Tung di (32 ha). Almost old trees were cut down and were replaced by regeneration forest of *Podocarpus feuryi*. Its density in the Catba area is 2,650 trees/ha and 7,000 seedling/ha (But 1989).

### Wind dry scrubs on rocky summit

#### 1. *Impatiens-Dracaena cambodiana* community

The stunted scrub vegetation of a fully open and sparse canopy occur at convex rocky ridges and summits of which the habitat condition is hot and dry owing to strong wind and sunlight. This is classified into the *Impatiens-Dracaena cambodiana* community differentiated by *Dracaena cambodiana*, *Impatiens pygmaea* and *Boehmeria holocericea* (Table 3). Other main species are of *Dracaena*, *Clematis*, *Jasminum*, *Euphorbia*, *Bauhinia*, *Derris*, and *Sasa* in the ground layer. The community consists of 2 layers

**Table 2.** *Blechnum-Pitecellobium ferrugineum* community of secondary forest type of humid tropical forest on deep soil in limestone area

Relevé No.: 27-2; Relevé site (date): Ang Dang in Trung Trang Village Cat Ba District in Haiphong Province, Vietnam (July. 27. 1997); Altitude: 60 m; Exposition: SWW; Slope: 3°; Area: 900 m<sup>2</sup> (30 × 30); Topography: Lower slope near valley; Microtopography: flat; Soil: Brown forest soil; Substrate: Loamy sand; Mother stone: limestone; Human impact: intensive. Height and coverage of tree layer-1 : 24 m, 100%; Height and coverage of tree layer-2 : 15 m, 60%; Height and coverage of shrub layer : 8 m, 40%; Height and coverage of herb layer : 2.5 m, 80%; Species composition : 25 spp.

Species of tree layer-1 : *Pitecellobium ferrugineum* 9,

Species of tree layer-2 : *Pitecellobium ferrugineum* 6, *Dracontomelum duperreanum* 6, *Mallotus paniculatus* 5, *Pterospermum heterophyllum* 5, *Castanopsis album* 6, *Aglaia gigantea* 6,

Species of shrub layer : *Pterospermum heterophyllum* 6, *Dillenia heterophylla* 5, *Bridelia balansae* 2, *Garcinia oblongifolia* 5, *Lindera glauca* 5, *Sterculia nobilis* 3,

Species list of herb layer : *Alpinia* sp., *Blechnum orientale*, *Pteris semipennata*, *Caryota bacsonensis*, *Microcos paniculata*, *Strobilanthus* sp., *Pavetta graciliflora*, *Maesa balansae*, *Elaeocarpus dubius*, *Rubus cochinchinensis*, *Microstegium vagans*, *Psychotria rubra*, *Polygonum chinensis*, *Ardisia quinquegona* agg.

**Table 3.** *Impatiens-Dracaena cambodiana* community

Relevé No.: 28-4; Relevé site (date): Hien Hao Village, Cat Ba District in Haipong Province, Vietnam (July, 28, 1997); Altitude: 45 m; Exposition: SW; Slope: 60°; Area: 25 m<sup>2</sup> (5 × 5); Topography: ridge; Microtopography: irregular; Soil: lithosols; Substrate: sand; Mother stone: limestone; Human impact: partly pasture. Height and coverage of shrub layer: 3 m, 10%; Height and coverage of herb layer: 0.5 m, 40%; Species composition: 9 spp.

Species composition: *Dracaena cambodiana*, *Premna fulva*, *Pilea alongensis*, *Impatiens pygmaea*, *Eupatorium odoratum*, *Bidens bipinnata*, *Boehmeria holocericea*, *Amorphophallus paeonifolia*, *Chirita eberhardtii*.

not exceeding 5 m and its biomass of timber is 50 m<sup>3</sup>/ha. The *Impatiens-Dracaena cambodiana* community is considered as an endemic plant community and a kind of paraclimax (pseudoclimax) types in the limestone areas. Most stands have been extensively changed by putting sheep out to pasture and cutting down and replaced by the dry- and light-tolerating shrubs belonging to Vacciniaceae, Myricaceae, Dracaenaceae, Euphorbiaceae, Fabaceae, Araliaceae, Balsaminaceae, Caesalpinaceae, Gesneriaceae, and Melastomataceae.

## Mangroves

### 1. *Rhizophora apiculata* community, *Avicennia marina* community, *Panicum repens* community

The mangrove vegetation is found along littoral with muddy soil especially in the Northwest area of the island at Phu long - Cai Vieng and around beach of Duong gianh. It is dominated by *Rhizophora apiculata*, *Bruguiera* spp., *Avicennia marina*, *Kandelia candel*, *Aegiceras majus*. The trees attain 2~3 m in height and plant community shows extremely simple species diversity (cf. the world's mangrove species of 69 taxa including 62 species and 7 hybrids). Because coastal habitats of this study area exist in the northernmost distribution of colder winter regions in which involve low concentration of salt, shallow muddy soil, and over exploitation (Miyawaki *et al.* 1984, Scott 1989). Three types composed of only 6 species were identified: *Rhizophora apiculata* community, *Avicennia marina* community, and *Panicum repens* community (Table 4).

The *Rhizophora apiculata* community is dominated by a single species *R. apiculata* in 4 m high but

**Table 4.** Vegetation of mangrove in the Catba National Park of Vietnam

A : *Rhizophora apiculata* community

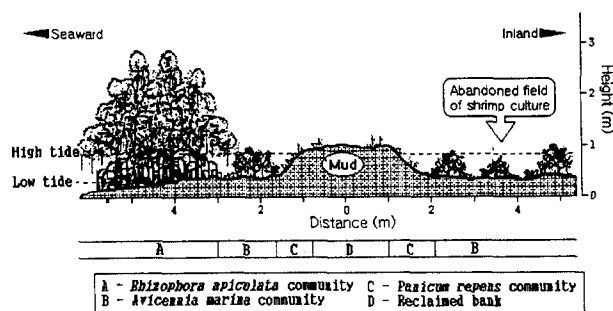
B : *Avicennia marina* community

C : *Panicum repens* community

	A	B	C
Relevé No.:	28-1	28-2	28-3
Altitude (m):	0	2	5
Exposition:	—	SE	SE
Slope (°):	0	1	5
Area (m <sup>2</sup> ):	20	2	0.2
Height of vegetation (m):	4	0.2	0.2
Coverage of vegetation (%):	100	50	20
Species composition (spp.):	1	4	2
<i>Rhizophora apiculata</i>	9	1	·
<i>Avicennia marina</i>	·	5	·
<i>Bruguiera gymnorrhiza</i>	·	5	·
<i>Excoecaria agallocha</i>	·	2	·
<i>Panicum repens</i>	·	·	6
<i>Fimbristylis dichotoma</i>	·	·	1

Relevé site (date): Phu Long in Cat Ba District in Haipong Province, Vietnam (July, 28, 1997).

dwarfish physiognomy due to unfavourable growing conditions in the northernmost distribution and severe human impacts. The *Avicennia marina* community



**Fig. 3.** A profile diagram of mangrove vegetations composed of *Rhizophora apiculata* community, *Avicennia marina* community, and *Panicum repens* community.

is co-mixed by *Avicennia marina* and *Bruguiera gymnorhiza*. This community is a secondary and pioneer vegetation type substituting the *Rhizophora apiculata* community after cutting. Most sites were formerly shrimp farming lands (Aksarnkone 1985). The weedy grasses such as *Panicum repens* and *Fimbristylis dichotoma* grow along the path slopes in small area (0.2 m<sup>2</sup>) (Fig. 2). This phytocoenosis is classified into *Panicum repens* community (Saumgesellschaft).

### Scramble vegetation (Mantlegesellschaft)

#### 1. *Heterosmilax-Zanthoxylum nitidum* community

The *Heterosmilax-Zanthoxylum nitidum* community is a humid type of lianas phytocoenosis well-developing along the road side as a pioneer forest-edge plant community (Mantelgesellschaft). This community is identified by many scramble species such as *Zanthoxylum nitidum*, *Clerodendrum kaempferi*, *Desmos chinensis*, *Cayratia trifolia*, *Acacia pennata*, *Crestemon tonkinensis*, *Caesalpinia balansae*, *Stemona tuberosa*, *Heterosmilax* sp., and *Stephania hernandifolia* (Table 5).

### Weed vegetation (Saumgesellschaft)

Many mountain paths by indigenous people are scattered at higher altitude above 90 m in the mountain range of the Catba national park. Site condition of paths is highly humid and infrequently trampled. Two kinds of plant community are found: *Stachytarphyta jamaicensis-Bidens bipinnata* community (Table 6) and *Microstegium vagans* community (Table 7).

The *Stachytarphyta jamaicensis-Bidens bipinnata* community is differentiated by dominant *Bidens bipinnata* and co-dominant *Stachytarphyta jamaicensis*. *Bidens bipinnata*, a cosmopolitan plant, is of an archeophyten species and occurs frequently at dumping sites. This community is often found at the new-established soil and open canopy. On the other hand, the *Microstegium vagans* community is differentiated by *Microstegium vagans* and *Pteris semipennata*. This community occurs at highly humid deep soils, and retains original paths not to be broadened by trampling.

In the roadside slopes, perennial ferny vegetation, i. e., the *Dicranopteris linearis* community is found (Table 8). The site conditions are characterized by immature soils, irregular cutting and firing, and semi-dry convex topography. This community is differentiated by dominance of *Dicranopteris linearis* and co-occurrence of *Miscanthus sinensis*.

### Anthropogenic trampling vegetations

#### 1. *Randina-Sapium sebiferum* community, *Psidium guajava* community, *Elephantopus scaber* community, *Eleusine indica* community

There are some anthropogenic plant communities oriented by trampling influences in the pasture lands and urbanized areas. In the alluvial areas (ca. 50 m a.s.l.) in between mountain ranges, oxen pastures are frequent. Habitat conditions of sites are peculiar like impenetrable, airless, and humid soil condition due to trampling effect and selective grazing (Fig. 3). In such sites three plant communities are found: *Randina-Sapium sebiferum* community, *Psidium guajava* community, *Elephantopus scaber* community. Their

**Table 5.** *Heterosmilax-Zanthoxylum nitidum* community

Relevé No.: 28-8; Relevé site (date): Tram Dong Co, Hien Hao Village, Cat Ba District in Haiphong Province, Vietnam (July. 28. 1997); Altitude: 45 m; Exposition: SW; Slope: 1°; Area: 10 m<sup>2</sup> (1 × 10); Topography: flat; Microtopography: slightly convex; Soil: ?; Substrate: sandy clay; Mother stone: limestone; Human impact: cutting. Height and coverage of shrub layer: 4 m, 100%; Height and coverage of herb layer 0.8 m, 20%; Species composition: 16 spp (\* including 10 lianes)

Species composition: \**Zanthoxylum nitidum*, \**Clerodendrum kaempferi*, \**Desmos chinensis*, *Securingea spirei*, \**Cayratia trifolia*, \**Acacia pennata*, *Iodes cirrhosa*, \**Crestemon tonkinensis*, *Randia dumetorum*, \**Caesalpinia balansae*, \**Stemona tuberosa*, \**Heterosmilax* sp., \**Stephania hernandifolia*, *Polygonum chinensis*, *Croton tiglium*, *Eupatprium odoratum*.

**Table 6.** *Stachytarphyta jamaicensis-Bidens bipinnata* community

Relevé No.: 27-4; Relevé site (date): Ang Dang in Trung Trang Village Cat Ba District in Haipong Province, Vietnam (July. 27. 1997); Altitude: 90 m; Exposition: NW; Slope: 3°; Area: 20 m<sup>2</sup> (2 × 10); Topography: -; Microtopography: flat ; Soil: Brown forest soil; Substrate: -; Mother stone: -; Human impact: intensive along the mountain footpath. Height and coverage of herb layer : 0.6 m, 100%; Species composition : 11 spp.

Species composition : *Bidens bipinnata* 9, *Ocimum gratissimum* 3, *Eupatorium odoratum* 1, *Polygonum chinensis* 1, *Phyllanthus reticulata* 1, *Iodes cirrhosa* 1, *Sida rhombifolia* 1, *Urena lobata* 1, *Rubus cochinchinensis* 2, *Pueraria montana* 3, *Stachytarpheta jamaicensis* 5.

**Table 7.** *Microstegium vagans* community

Relevé No.: 27-3; Relevé site (date): Ang Dang in Trung Trang Village Cat Ba District in Haipong Province, Vietnam (July. 27. 1997); Altitude: 60m; Exposition: -; Slope: 0°; Area: 15 m<sup>2</sup> (3 × 5); Topography: -; Microtopography: concave ; Soil: Brown forest soil; Substrate: -; Mother stone: -; Human impact: intensive along the mountain footpath. Height and coverage of herb layer : 1.3 m, 100%; Species composition : 7 spp.

Species composition : *Melastoma candidum* 2, *Pteris semipennata* 5, *Microstegium vagans* 7, *Mussaenda saigonensis* 3, *Rubus cochinchinensis* 3, *Polygonum chinensis* 2, *Lycopodium scandens* 4.

**Table 8.** *Dicranopteris linearis* community

Relevé No.: 28-11; Relevé site (date): Da Lat, Hien Hao Village, Cat Ba District in Haipong Province, Vietnam (July. 28. 1997); Altitude: 60 m; Exposition: SW; Slope: 50°; Area: 16 m<sup>2</sup> (4 × 4); Topography: ridge; Microtopography: convex; Soil: Immature soil; Substrate: ?; Mother stone: limestone; Human impact: cutting & fire. Height and coverage of herb layer-1 : 1 m, 20%; Height and coverage of herb layer-2 : 0.25 m, 100%; Species composition : 11 spp.

Species composition : *Dicranopteris linearis* 8, *Derris* sp. 1, *Miscanthus sinensis* 3, *Melastoma candidum* 1, *Melastoma decemfidum* 1, *Blechnum orientale* 1, *Rhodomyrtus tomentosa* 1, *Breynia fruticosa* 1, *Desmos triangulare* 1, *Lindsaea annamensis* 2, *Polygonatherium crinitum* 2.

habitats are influenced by the monsoon flooding. The *Eleusine indica* community is representative of the urbanized areas.

The *Randiana-Sapium sebiferum* community is characterized by *Sapium sebiferum* of pioneer species in shrub layer up to 7 m and co-mixed by *Eupatorium odoratum* and *Psidium guajava* in ground layer (Table 9). A species composition of this community is rather simple (only 4 species in 400 m<sup>2</sup>) owing to selectively grazing. The *Psidium guajava* community (Table 10) forms a sparse patch composed of *Eupatorium odoratum* and *Psidium guajava*. Its habitats show more or less convex topography which is relatively dry. The *Elephantopus scaber* community is differentiated by *Chrysopogon aciculatus*, *Desmodium triphyllum*, *Elephantopus scaber*, and *Ischaemum ciliare*. These diagnostic species are characteristic of growth forms, i.e., well-knit rosettes and tight ramets. The habitats are flat and severely trampled by oxen

and sheep (Table 11). In the urbanized areas of the Catba national park, the *Eleusine indica* community is growing at extremely dry and trampling sites (Table 12). Some species characterizing such site conditions are co-mixed, *Eleusine indica*, *Chrysopogon aciculatus*, and *Stachytarpheta jamaicensis*. This community is found in reclaimed sandy soil between the asphalt and/or cement crevices. While the *Digitaria barbata* community is characterized on the clay soil.

## Limestone cave vegetation

### 1. *Chirita aratiformis* community

In the Catba national park, there are many caves with various sizes. Some of them have utilized as military dugout and hospital during World War II. Very limited vegetation grows depending on extremely minor light. In this study, the *Chirita aratiformis* community was described from the Hungson Cave, Hien



**Table 9.** The *Randiana-Sapium sebiferum* community

Relevé No.: 28-5; Relevé site (date): Tram Dong Co, Hien Hao Village, Cat Ba District in Haiphong Province, Vietnam (July. 28. 1997); Altitude: 40 m; Exposition: -; Slope: 0°; Area: 400 m<sup>2</sup> (20 × 20); Topography: alluvial; Microtopography: concave; Soil: ?; Substrate: sandy clay; Mother stone: limestone; Human impact: pasture. Height and coverage of shrub layer : 7 m, 100%; Height and coverage of herb layer : 3 m, 60%; Species composition : 4 spp.

Species composition : *Sapium sebiferum* S-9, H-5, *Randia dumetorum* H-6, *Eupatorium odoratum* H-7, *Psidium guajava* H-7.

**Table 10.** The *Psidium guajava* community

Relevé No.: 28-6; Relevé site (date): Tram Dong Co, Hien Hao Village, Cat Ba District in Haiphong Province, Vietnam (July. 28. 1997); Altitude: 40 m; Exposition: -; Slope: 0°; Area: 2 m<sup>2</sup> (1 × 2); Topography: alluvial; Microtopography: convex; Soil: ?; Substrate: sandy clay; Mother stone: limestone; Human impact: pasture. Height and coverage of herb layer : 0.5 m, 70%; Species composition : 2 spp.

Species composition : *Eupatorium odoratum* H-7, *Psidium guajava* H-7.

**Table 11.** The *Elephantopus scaber* community

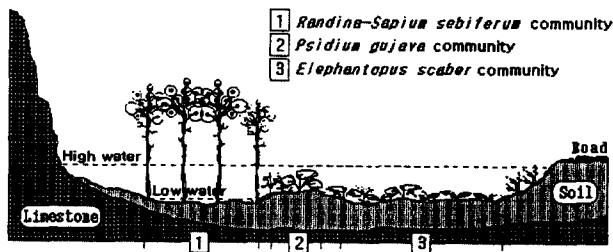
Relevé No.: 28-7; Relevé site (date): Tram Dong Co, Hien Hao Village, Cat Ba District in Haiphong Province, Vietnam (July. 28. 1997); Altitude: 40 m; Exposition: -; Slope: 0°; Area: 1 m<sup>2</sup> (1 × 1); Topography: alluvial; Microtopography: flat; Soil: ?; Substrate: sandy clay; Mother stone: limestone; Human impact: pasture & trodden. Height and coverage of herb layer : 0.1 m, 100%; Species composition : 4 spp.

Species composition : *Chrysopogon aciculatus* 7, *Desmodium triphyllum* 6, *Elephantopus scaber* 6, *Ischaemum ciliare* 7.

**Table 12.** *Eleusine indica* community

Relevé No.: 28-9; Relevé site (date): Tram Dong Co, Hien Hao Village, Cat Ba District in Haiphong Province, Vietnam (July. 28. 1997); Altitude: 45 m; Exposition: -; Slope: 0°; Area: 10 m<sup>2</sup> (1 × 10); Topography: reclaimed; Microtopography: convex; Soil: ?; Substrate: sandy clay; Mother stone: limestone; Human impact: trodden. Height and coverage of herb layer : 0.2 m, 100%; Species composition : 5 spp.

Species composition : *Eleusine indica*, *Chrysopogon aciculatus*, *Eupatorium odoratum*, *Stachytarpheta jamaicensis*.



**Fig. 4.** A profile diagram of anthropogenic trampling vegetations composed of *Randiana-Sapium sebiferum* community, *Psidium guajava* community, and *Elephantopus scaber* community.

Hao Village, Cat Ba District in Haiphong Province, where locates 65 m a.s.l. and 90° inclined cliff in the northwestern slope (Table 13). This plant community

is composed of *Chirita aratiformis*, *Adiantum caudatum*, *Ctenifopsis coloniae*, Moss sp.

## DISCUSSIONS AND CONCLUSIONS

A phytosociological description on the vegetation of the Catba national park was first accomplished. It is recognized that there are seven vegetation types including 15 plant communities in the Catba national park:

- (1) Tropical monsoon humid forests on limestone *Teetaria-Amoora gigantea* community (a primary forest)
- Blechnum-Pitecellobium ferrugineum* community (a secondary forest)
- (2) Wind dry scrubs on rocky summit

**Table 13.** *Chirita aratiformis* community

Relevé No.: 28-10; Relevé site (date): Hungson Cave, Old Arang Hospital, Hien Hao Village, Cat Ba District in Haipong Province, Vietnam (July. 28. 1997); Altitude: 65 m; Exposition: NW; Slope: 90°; Area: 12 m<sup>2</sup> (3 × 4); Topography: cliff; Microtopography: convex & concave; Soil: ?; Substrate: -; Mother stone: limestone; Human impact: -. Height and coverage of herb layer : 0.25 m, 30%; Species composition : 4 spp.

Species composition : *Chirita aratiformis*, *Adiantum caudatum*, *Ctenifopsis coloniae*, *Moss* sp.

- Impatiens-Dracaena cambodiana* community
- (3) Mangrove vegetations  
*Rhizophora apiculata* community  
*Avicenia marina* community  
*Panicum repens* community
- (4) Scramble vegetation (Mantlegesellschaft)  
*Heterosmilax-Zanthoxylum nitidum* community
- (5) Weed vegetation (Saumgesellschaft)  
*Stachytarphyta jamaiensis-Bidens bipinnata* community  
*Microstegium vagans* community  
*Dicranopteris linearis* community
- (6) Anthropogenic trampling vegetations  
*Randina-Sapium sebiferum* community  
*Psidium gujava* community  
*Elephantopus scaber* community  
*Eleusine indica* community
- (7) Limestone cave vegetation  
*Chirita aratiformis* community

From the phytosociological viewpoints, the vegetation of Catba national park is almost substituted by some of secondary vegetations owing to human interference. In Catba national park, exploitation is far above sustainable levels (Thin 1994). Largely two disturbance regimes in this area were recognized, *i.e.*, pasturing and firing in the mountain ranges were the most significant impacts to destroy the natural ecosystem. Especially, pasturing into inner-forest is threatening some endangered and shadow-tolerating plants in the forest floor. Several suspected effects by pasturing in the inner-forest are a diminishing of specific flora resulting from selectively grazing, physical disturbance of native herbs by trampling, and soil eutrophication by livestock.

One of the most severe destroy of natural forests in the Catba national park's area results from tradi-

tional shifting agriculture by indigenous people. Loss of natural forest land and cover to agriculture constitutes a major threat to the health and survival of the plants and animals of Catba national park's native forests. Indigenous knowledge to make fields is composed of at first cutting down mainly natural forests instead of secondary forests and putting in fire, and finally waiting for soil mineralization. In addition to loss of forest area, results are indicating a general decline in quality of the remaining forest. The main causes of degradation in forest quality are uncontrolled commercial logging and charcoal making and extraction of polewood and firewood for both domestic and commercial purposes. Unregulated livestock grazing in steep slopes also may have localized adverse effects. Such areas are covered by scrub vegetation. Despite the bans, however, illegal activities continue apace. Therefore, ecological strategies for conservation and sustainable use on natural resources are needed: (1) developing awareness program for sustainable life style of indigenous people in combination of farmer's right, (2) establishment of multiple use module (MUM) system for national park, (3) setting up permanent ecological sites for ecosystem monitoring.

## 적 요

베트남 동북지역의 대표적인 보호구역인 캣바국립공원 (Catba national park, 20°42'~20°54'N, 106°54'~107° 09'E)에 대하여 Z.-M.학파의 식물사회학적 방법에 의하여 연구되었다. 본 연구는 베트남에서 이루어진 최초의 식물사회학적 연구이다. 7개의 식생형으로부터 15개의 식물군락이 구분되었다: *Teetaria-Amoora gigantea* community, *Blechnum-Pitecellobium ferrugineum* community, *Impatiens-Dracaena cambodiana* community, *Rhizophora apiculata* community, *Avicenia marina* co-

community, *Panicum repens* community, *Heterosmilax-Zanthoxylum nitidum* community, *Stachytarphyta jamaicensis-Bidens bipinnata* community, *Microstegium vagans* community, *Dicranopteris linearis* community, *Randina-Sapium sebiferum* community, *Psidium guajava* community, *Elephantopus scaber* community, *Chirita aratiformis* community. 캣바국립공원 구역 내에 징주하는 토착민의 전통적 방목과 화전농경은 지속가능한 개발의 수준을 넘어 본 국립공원의 주된 파괴요인이었다. 자연자원에 대한 보전과 지속가능한 이용을 위한 생태적 전략이 제안되었다: 토착민의 지속가능한 생활방식에 대한 계몽, 국립공원의 다이올체계 수립, 생태계 모니터링을 위한 영구생태감시지구 설정.

### LITERATURE CITED

- Aksarnkone, S. 1985. Present status of the global mangrove ecosystem. Ecological status on the Vegetation of mangrove forests in Thailand (ed A. Miyawaki) p.p. 15-124, Yokohoma.
- Becking, R.W. 1957. The Zürich-Montpellier school of phytosociology. *Bot. Rev.* 23: 411-488.
- Braun-Blanquet, J. 1965. Plant Sociology. The Study of Plant Communities. Hafner Publishing Company, New York and London. 439p.
- But, T.N. 1989. Plant Resources of forest in Catba National Park.
- Ho, P.H. 1992, 1993. An Illustrated Flora of Vietnam. Vol. 1 (No. 1,2), Vol. 2 (No. 1,2), Vol. 3 (No. 1, 2). Mekong Printing, CA.
- Ministry of Forest. 1992. Brief Introduction of to Catba National Park.
- Miyawaki, A., K. Fujiwara, K. Ohno and J.W. Kim. 1984. A syntaxonomical study of mangrove vegetation in Thailand. 5. On the actual vegetation and potential natural vegetation. Abstract of the 31st Conference of the Japanese Society of Ecology, 4p. Tokyo.
- Müller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. J. Willey and Sons, New York. 547 pp.
- Santisak T. 1983. Taxonomy and distribution of terrestrial trees and shrubs in the Mangrove formations in Thailand. *Natural History Bulletin of the Society.* 31(1): 63-91.
- Scott, D.A. (ed). 1989. A Directory of Asian Wetlands, IUCN Gland, Switzerland and Cambridge, UK. 181pp.
- Thin, N.N. 1994. Diversity of the Cuc Phuong flora, A primary forest of Vietnam. proceeding of the NCST of Vietnam. 6(2): 77-82.
- Thin, N.N. and D.K. Harder. 1996. Diversity of the flora of Fan Si Pan, the highest mountain in Vietnam. *Ann. Missiuri Bot. Gard.* 83: 404-408.
- van der Maarel, E. 1979. Transformation of cover-abundance values in phytosociology and its effects on community similarity. *Vegetatio* 39: 97-114.
- Westhoff, V. and E. van der Maarel. 1973. The Braun-Blanquet approach. In: *Ordination and Classification of community* (ed. H. Whittaker). p. 619-658. Dr. W. Junk b.v. Publishers, The Hague.

(Received March 9, 1998)