

Spatial organization of a tropical lizard community in a forested area in northern Vietnam

Die räumliche Verteilung der Arten einer tropischen Eidechsen-gesellschaft
in einem Waldgebiet Nordvietnams

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KURZFASSUNG

Die räumliche Verteilung einer tropischen Eidechsen-gesellschaft im Cuc Phuong Nationalpark (Nordvietnam) wurde im Dezember 1988, September 1989 und April 1991 untersucht. Die Gesellschaft setzt sich aus 15 Arten zusammen, die 5 Familien angehören: Gekkonidae (3 Arten), Agamidae (3), Scincidae (7), Lacertidae (1), Varanidae (1).

Das Gebiet von Cuc Phuong läßt sich den drei Hauptlebensräumen Tropenwald, Grasland und Flußufer zuordnen. Die Clusteranalyse der Mikrohabitate der 15 Eidechsenarten ergab 4 Artengruppen: Bewohner großer hoher Bäume (2 Arten), "andere baumbewohnende" Eidechsen (5), Waldbodenbewohner (7) und Graslandbewohner (1). Die häufigste Art in Cuc Phuong war *Sphenomorphus tritaeniatius*, gefolgt von *Acanthosaura lepidogaster*, der häufigsten baumbewohnenden Art. Viele Arten sind diskontinuierlich im Wald verteilt.

ABSTRACT

The spatial structure of a tropical lizard community living in the Cuc Phuong National Park (Northern Vietnam) was studied in December 1988, September 1989, and April 1991. The community is made up of 15 species which belong to 5 families: Gekkonidae (3 species), Agamidae (3), Scincidae (7), Lacertidae (1), and Varanidae (1).

Habitat partitioning and microhabitat utilization of the lizards were analyzed. The environment at Cuc Phuong can be assigned to three major habitat types: tropical forest, grassland, and river banks. 15 kinds of microhabitats were distinguished. Cluster analysis revealed 4 groups of species: inhabitants of big high trees (2 species), "other arboreal" species (5), forest floor dwellers (7), and grassland inhabitants (1). The most abundant species at Cuc Phuong is *Sphenomorphus tritaeniatius*, followed by *Acanthosaura lepidogaster*, which is the most abundant arboreal species. Many species are patchily distributed within the forest.

KEYWORDS

Gekko gecko, *G. chinensis*, *Hemidactylus frenatus*, *Acanthosaura lepidogaster*, *Calotes versicolor*, *Draco maculatus*, *Eumeces quadrilineatus*, *Scincella* sp., *S. reevesii*, *Sphenomorphus tritaeniatius*, *Tropidophorus* sp. nov., *T. baviensis*, *T. hainanus*, *Tachydromus sexlineatus*, *Varanus salvator*, lizard communities, ecology, tropical rain forest ecology, spatial organization, North Vietnam

INTRODUCTION

Lizards are conspicuous organisms in most tropical regions of the world. As such, they received considerable attention from ecologists. However, knowledge of lizard communities in tropical rain forests is meagre. Because of the dense vegetation and the quantity of leaf litter that covers the ground, lizards are very difficult to observe in tropical forests.

Few communities have been studied so far in South America (RAND & HUMPHRY 1968; CRUMP 1971; DUELLMAN 1987), tropical Asia (BROWN & ALCALA 1964; LLOYD & al. 1968;

INGER & COLWELL 1977; INGER & al. 1987), Africa (SIMBOTWE 1984) and Northern Australia (MARTIN & FREEDLAND 1988).

The herpetofauna of Vietnam is one of the poorly known in tropical Asia. The main objective of this paper was to study specific features of the spatial organization and niche patterns in a community of Vietnamese tropical forest lizards.

Detailed microhabitat information was gathered on 495 specimens comprising 15 lizard species from Cuc Phuong National Park.

STUDY SITE AND METHODS

Study site

Field work was carried out during December 1988, September 1989 and May 1991 in the Cuc Phuong National Park (20°14' - 20°24' N, 105°24' - 105°44' E) (fig. 1). About 100 kilometers south-west of Hanoi, the Park extends over 22200 hectares, astride of three contiguous provinces with 51.1% of its area in Ha Nam Ninh, 26.4% in Ha Son Binh and 22.5% in Thanh Hoa. Its territory is surrounded by the ranges of calcareous mountains (elevation 300 - 400 m above sea level, the highest peak being 648.2 m) (ANONYMUS 1987). Soils belong to the class of humid tropical soils (FRIDLAND 1964).

Climatically, this is a tropical monsoon region; every year southwest monsoon season lasts on the average from April to September inclusive (NGO 1972). In the vicinity of Hanoi the annual average temperature is about 24° C and annual precipitations equal to 1700-1800 mm (VITVITSKY 1960).

The flora of Cuc Phuong numbers 1967 plant species (989 genera, 217 families) including 1675 angiosperm species (749 genera, and 152 families) (ANONYMUS 1987).

The vegetation was described by GORDEYEVA & al. (1991). In a permanent sample plot (50 m x 50 m) we registered at least 145 vascular plant species belonging to 49 families. The underwood layer (tree regeneration, shrubs) holds most of the species (72), and only few (18) are found in the herb layer. This is typical to almost all tropical rain forests (RICHARDS 1957). Lianas and epiphytes make up a considerable part (17 species in the underwood, 14 in the herb layer). The stand of timber is formed by 101 individuals of trees belonging to 31 species. *Saraca dives* (Caesalpinaceae) prevails (27 individuals); 3 species are represented by 6 - 10 trees per plot and 27 species by 1 - 5 trees, i. e. the overwhelming majority of

species is represented by a small number of trees.

Methods

The environment at Cuc Phuong can be assigned to three major habitats: tropical forest, river bank and grassland (fig. 2).

Each habitat was censused for lizards by conducting random one-kilometer trails at various times. The effective observation area was about 2,5 m off either side of the trails and to a height of about 6 m above the ground. Location on the trail, microhabitat, height above ground, time of day, and activity were noted for each lizard observed or collected. An approximately equal amount of field work was done by day and by night. About 100 person-hours were spent walking along 30 km of trail.

Preserved specimens are deposited in the herpetological collection at the Cuc Phuong Zoological Museum. 15 kinds of microhabitats were distinguished (see tables 1, 2, 3).

We calculated niche breadth using the diversity index of SIMPSON (1949):

$$B = (\sum p_i^2)^{-1}$$

p_i represents the proportion of individuals of a species found in the i -th microhabitat.

For niche overlap we used PIANKA's index:

$$O_{jk} = \frac{\sum p_{ij} p_{ik}}{\sqrt{\sum p_{ij}^2 \sum p_{ik}^2}}$$

p_{ij} and p_{ik} are the proportions of the j -th and k -th species in the i -th resource state (PIANKA 1973).

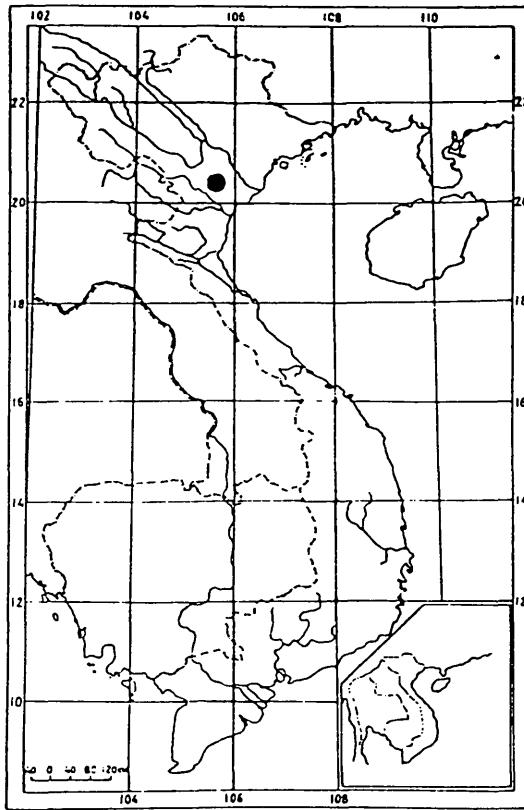


Fig. 1: The location of the Cuc Phuong National Park, Vietnam.
 Abb. 1: Die Lage des Cuc Phuong Nationalparks in Vietnam.

RESULTS

Composition of the community

24 species of lizards are known from Cuc Phuong (LE HIEN HAO 1971; DAREVSKY & NGUYEN 1983; DAREVSKY & al. 1984, 1986; HIKIDA & DAREVSKY 1987). 15 of these were observed or collected. One species of *Tropidophorus* will be described as new elsewhere (BOBROV, in press). Observed distribution of species and number of individuals of each species in the habitats are given in table 1. 15 species of lizards are members of five families: Gekkonidae, Agamidae, Scincidae, Lacertidae, and Varanidae. The lizard species can be divided into the three

major categories: terrestrial, arboreal and riparian. Three geckoes are all nocturnal, the other species are diurnal.

An overview of microhabitat partitioning

In table 1 the fauna is assigned to three main habit types (terrestrial, arboreal, riparian), and the differences and similarities in microhabitat use among the species of these groups are shown.

Terrestrial lizard species differ markedly among themselves (table 2). The skins can be classified according to the degree of obscurity they live in. *Eumeces*

Table 1: Number of specimens of 15 lizard species found in three major habitats at Cuc Phuong. 1 - tropical forest, 2 - grassland, 3 - river banks, 4 - center of distribution, 5 - habits.

Tabelle 1: Die 15 Eidechsenarten in Cuc Phuong und ihre jeweils beobachteten Stückzahlen in drei Hauptlebensräumen. 1 - Tropenwald, 2 - Grasland, 3 - Flußufer, 4 - Verbreitungszentrum, 5 - Lebensgewohnheiten.

Species	1	2	3	4 ¹⁾	5 ²⁾
	Specimens				
Gekkonidae					
<i>Gekko gecko</i>	15	-	-	F	AN
<i>Gekko chinensis</i>	10	-	-	F	AN
<i>Hemidactylus frenatus</i>	25	-	-	F	AN
Agamidae					
<i>Acanthosaura lepidogaster</i>	155	-	-	F	ATD
<i>Calotes versicolor</i>	35	-	-	F	AD
<i>Draco maculatus</i>	2	-	-	F	AD
Scincidae					
<i>Eumeces quadrilineatus</i>	10	-	-	F	TD
<i>Scincella reevesii</i>	25	-	-	F	TD
<i>Scincella</i> sp.	2	-	-	F	ATD
<i>Sphenomorphus tritaeniatus</i>	160	-	-	F	TD
<i>Tropidophorus baviensis</i>	20	-	-	F	TD
<i>Tropidophorus</i> sp. nov.	1	-	-	F	TD
<i>Tropidophorus hainanus</i>	4	-	-	F	TD
Lacertidae					
<i>Tachydromus sexlineatus</i>	-	30	-	G	TD
Varanidae					
<i>Varanus salvator</i>	-	-	1	R	RD

¹⁾F - predominantly or exclusively in tropical forest, G - predominantly or exclusively in grasslands, R - predominantly or exclusively on river banks.

²⁾The first symbol refers to the habit type: A - arboreal, R - riparian-aquatic, T - terrestrial. The second symbol refers to the active period: D - diurnal, N - nocturnal.

quadrilineatus and *Sphenomorphus tritaeniatus* were found on the forest floor; high percentages (100 - 91 %) of the individuals were caught in exposed situation. *Tropidophorus* fills a somewhat intermediate position (about 70 % found exposed), and *Scincella reevesii* seems to belong to the more secretive forms (28 % found exposed).

Concerning their resort, arboreal species (table 3) are as heterogeneous as terrestrial ones. *Calotes versicolor* was found in shrubs as well as trees, whereas *Draco maculatus* and *Gekko gecko* were

almost exclusively confined to large-sized trees. *Hemidactylus frenatus*, *Gekko chinensis*, *Scincella* sp. and *Acanthosaura lepidogaster* were caught at moderate heights (1 - 3 m above ground) others, such as *Draco maculatus* and *Gekko gecko*, mainly in higher strata.

A single (at least temporarily riparian) species, *Varanus salvator*, was observed on river banks.

Community organization

Niche breadths vary from 1.0 (*Gekko gecko*, *Draco maculatus*, *Tropidophorus* sp. nov., *Tachydromus sexlineatus*, *Varanus salvator*) to 5.0 (*Scincella reevesii*) (table 4).

The first mentioned five species were using only one kind of microhabitat each. Thus, 30% of the species seemed to be specialized in the use of substrate.

Niche overlap, as we understand it, is a measure of similarity in the use of microhabitats. The spatial niche overlap values for all pairs of species are shown in table 5. A rather simple picture of community structure (fig. 3) emerges from cluster analysis of the entire matrix of niche overlap values:

Group 1: Arboreal lizards, restricted to big high trees (*Gekko gecko*, *Draco maculatus*). This pair has the highest niche overlap (1.00).

Group 2: Arboreal lizards, not restricted to big high trees (*Gekko chinensis*, *Hemidactylus frenatus*, *Acanthosaura lepidogaster*, *Calotes versicolor*, *Scincella* sp.).

Group 3: Forest floor dwelling lizards. Three species (*Sphenomorphus tritaeniatus*, *Tropidophorus baviensis*, *T. hainanus*) have high overlap. Although overlap among 4 other species of this category (*Eumeces quadrilineatus*, *Scincella reevesii*, *Tropidophorus* sp. nov. and *Varanus salvator*) is moderate, they do not constitute a defined group in the sense of the previous.

Group 4: Terrestrial lizards: *Tachydromus sexlineatus* is a grassland dweller.

Table 2: Number of terrestrial lizards at Cuc Phuong grouped according to microhabitat. Note that *Scincella* sp. and *Acanthosaura lepidogaster* are included in both table 2 (terrestrial) and 3 (arboreal).

Tab. 2: Neun terrestrische Eidechsenarten in Cuc Phuong und ihre jeweils beobachteten Stückzahlen in verschiedenen Mikrohabitaten. *Scincella* sp. and *Acanthosaura lepidogaster* sind sowohl in Tab. 2 (terrestrisch) als auch in Tab. 3 (baumbewohnend) angeführt.

Species	total terrestrial	Grass-land	below Surface of Soil	covered by				exposed on			Percent* exposed
				Leaves	Rocks	Logs	Soil	Leaves	Rocks	Logs	
<i>Eumeces quadrilineatus</i>	10	-	-	-	-	-	-	-	3	7	100
<i>Scincella reevesii</i>	25	-	1	5	7	5	1	5	1	-	28
<i>Scincella</i> sp.	1	-	-	-	-	-	-	-	1	-	100
<i>Sphenomorphus tritaeniatus</i>	160	-	-	5	1	2	10	138	2	2	91
<i>Tropidophorus baviensis</i>	20	-	-	2	3	1	1	10	2	1	70
<i>Tropidophorus</i> sp. nov.	1	-	-	1	-	-	-	-	-	-	0
<i>Tropidophorus hainanus</i>	4	-	-	1	-	-	-	3	-	-	75
<i>Acanthosaura lepidogaster</i>	35	-	-	-	-	-	11	10	4	10	100
<i>Tachydromus sexlineatus</i>	30	30	-	-	-	-	-	-	-	-	-

* for forest inhabitants

Table 3: Number of arboreal lizards at Cuc Phuong grouped according to microhabitat and height of capture.

Tab. 3: Die baumbewohnenden Eidechsenarten in Cuc Phuong, ihre jeweils beobachteten Stückzahlen in verschiedenen Mikrohabitaten und die Fundhöhen über Grund.

Species	total arboreal	Stumps	Shrubs	Height of Capture (m) in Trees		
				1	1-3	>3
<i>Gekko gecko</i>	15	-	-	-	-	15
<i>Gekko chinensis</i>	10	-	-	5	5	-
<i>Hemidactylus frenatus</i>	25	-	-	21	4	-
<i>Acanthosaura lepidogaster</i>	120	10	10	25	65	10
<i>Calotes versicolor</i>	35	-	10	5	20	-
<i>Draco maculatus</i>	2	-	-	-	-	2
<i>Scincella</i> sp.	1	-	-	1	-	-

Table 4: Microhabitat niche breadth (B) for the 15 lizard species at Cuc Phuong.

Tab. 4: Nischenbreite der Mikrohabitats bei 15 Eidechsenarten in Cuc Phuong.

Species	B
<i>Gekko gecko</i>	1.00
<i>Gekko chinensis</i>	2.00
<i>Hemidactylus frenatus</i>	1.04
<i>Acanthosaura lepidogaster</i>	4.81
<i>Calotes versicolor</i>	2.29
<i>Draco maculatus</i>	1.00
<i>Eumeces quadrilineatus</i>	1.72
<i>Scincella reevesii</i>	5.00
<i>Scincella</i> sp.	2.00
<i>Sphenomorphus tritaeniatus</i>	1.34
<i>Tropidophorus baviensis</i>	3.33
<i>Tropidophorus</i> sp. nov.	1.00
<i>Tropidophorus hainanus</i>	1.60
<i>Tachydromus sexlineatus</i>	1.00
<i>Varanus salvator</i>	1.00

Table 5: Niche overlap in the Cuc Phuong lizard community. GG - *Gekko gecko*, GC - *Gekko chinensis*, HF - *Hemidactylus frenatus*, AL - *Acanthosaura lepidogaster*, CV - *Calotes versicolor*, DM - *Draco maculatus*, EQ - *Eumeces quadrilineatus*, SR - *Scincella reevesii*, SS - *Scincella* sp., ST - *Sphenomorphus tritaeniatatus*, TB - *Tropidophorus baviensis*, TC - *Tropidophorus* sp. nov., TH - *Tropidophorus hainanus*, TS - *Tachydromus sexlineatus*, VS - *Varanus salvator*.

Tab. 5: Nischenüberschneidung bei der Eidechsenegesellschaft von Cuc Phuong.

	GC	HF	AL	CV	DM	EQ	SR	SS	ST	TB	TC	TH	TS	VS
GG	0.00	0.00	0.14	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GC		0.83	0.63	0.42	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00
HF			0.50	0.20	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00
AL				0.90	0.14	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00
CV					0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00
DM						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EQ							0.03	0.17	0.02	0.16	0.00	0.00	0.00	0.00
SR								0.05	0.36	0.54	0.33	0.42	0.00	0.20
SS									0.01	0.13	0.00	0.00	0.00	0.00
ST										0.93	0.04	0.95	0.00	0.00
TB											0.18	0.92	0.00	0.00
TC												0.32	0.00	0.00
TH													0.00	0.00
TS														0.00

Table 6: Number of lizard species found sympatric in five forest study sites.

Tab. 6: Anzahlen sympatrisch lebender Eidechsenarten an Untersuchungsstellen in fünf Waldgebieten.

Lizard Family	Study Site				
	Philippines, Negros Isl. (BROWN & ALCALA 1964)	Borneo, Nanga-Tekalit (LLOYD & al. 1968)	Thailand, Sakaerat (INGER & COLWELL 1977)	India, Kerala, Ponnudi (INGER & al. 1987)	Vietnam, Cuc Phuong
Gekkonidae	9	9	10	5	3
Agamidae	4	12	7	7	3
Dibamidae	1	1	-	-	-
Scincidae	13	15	11	6	7
Lacertidae	-	-	-	-	1
Varanidae	1	3	-	-	1
Total	28	40	28	18	15

DISCUSSION

There are obvious differences in species richness and community structure at different sites of the Indo-Malayan forests. Table 6 demonstrates that - although the number of species is highly variable - percentage of families is similar.

Nanga Tekalit with the highest number of species is unique among the sites in having no dry season (LLOYD & al. 1968).

The basic habitat of reptiles is the terrestrial one. Many lizards indeed live on the soil, occasionally hiding between small plants or rocks or under dead leaves. The majority of lizards in tropical Asia are

members of the family Scincidae, and skinks are the predominant terrestrial lizards on each site. A few forest species acquire subterrestrial habitats. In this respect Dibamidae, which are present in two sites, are the most specialized Indo-Malayan lizards. Another burrowing lizard, *Brachymeles*, is found among the scincids of Negros Island.

Tropical forests hold a variety of niches in the vertical. So arboreal gekkonids and agamids are present in each site. Even a few scincids (*Dasia* spp., *Lipinia* spp.) invaded arboreal habitats. Two Indo-Malayan lizards are largely aquatic, *Vara-*



Fig. 2: The tropical rain forest at Cuc Phuong National Park (photo by D. V. POPKOV).

Abb 2: Der tropische Regenwald im Cuc Phuong Nationalpark (Aufnahme: D. V. POPKOV).

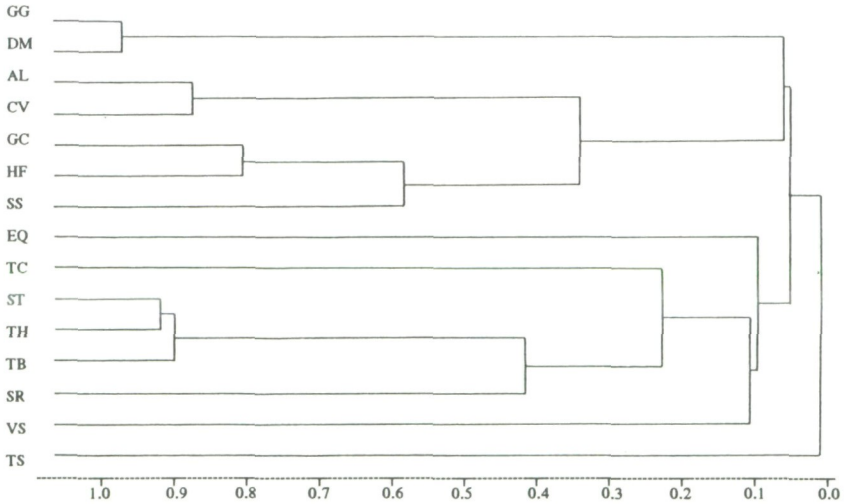


Fig. 3: Cluster analysis of spatial niche overlap in lizards at Cuc Phuong. GG - *Gekko gecko*, GC - *Gekko chinensis*, HF - *Hemidactylus frenatus*, AL - *Acanthosaura lepidogaster*, CV - *Calotes versicolor*, DM - *Draco maculatus*, EQ - *Eumeces quadrilineatus*, SR - *Scincella reevesii*, SS - *Scincella* sp., ST - *Sphenomorphus tritaeniatus*, TB - *Tropidophorus baviensis*, TC - *Tropidophorus* sp. nov., TH - *Tropidophorus hainanus*, TS - *Tachydromus sexlineatus*, VS - *Varanus salvator*.

Abb. 3: Clusteranalyse zur räumlichen Einnischung der Eidechsen in Cuc Phuong.

nus salvator (Cuc Phuong, Nanga Tekalit) and *Hydrosaurus pustulatus* (Negros Island).

Comparison of five tropical Asian lizard communities reveals that the community at Cuc Phuong comprises the smallest number of species. The most abundant lizard at Cuc Phuong is *Spheno-*

morphus tritaeniatus, followed by *Acanthosaura lepidogaster*, which is the most abundant lizard in trees. Eight species of lizards inhabit the leaf litter, seven live in trees, many are patchily distributed in the forest. In contrast to forests in the Philippines, Borneo, and Thailand there are only three gekkonid species present.

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