How does the fragmented forest influence the abundance dynamics of beetles group (Coleoptera) in a changing land-use system

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BACKGROUND

Background for selection of research site

- The Nabanhe Nature Reserve includes a variety of land-use type and have high biodiversity;
- Traditional land-use system were now suffering forcefully change because of rapid expansion of rubber plantation in NNR;
- More and more different size of fragmented forest formed by this kind of land-use changing.

Background for selection of research beetles group

- Land-use changing influenced the vegetation and soil structure profoundly;
- This influence then take a positive or negative feedback to the insects within it;
- Some beetles group (Coleoptera) are sensitively to the soil and vegetation transformation especially for dungbeetles(Geotrupidae) and groundbeetles(Carabidae).

PURPOSE AND HYPOTHESIS

Habitat factor have pervasive effects on behavior and spatial organization of organisms(Wrangham, *et al*., 1993). Most of research describing the effects of fragmentation on tropical biota only focused on the interior of the fragmented forest but neglect the influence on the neighbouring habitats which were taken by it. This study aimed at comparing the abundance dynamics of beetles in 3 different sites of NNR with 3 different habitats formed by the rapid land-use changing, and to check how does the site and micro-habitats this two important factors influence the abundance of beetles group through link the trap catching in internal and external fragmented forest in NNR.

The specific objectives of this study were:

(1)To determine the abundance dynamics of beetles group in NNR;

(2)To understand how land use changing influence the abundance of beetles through the specific effects of habitat and site.

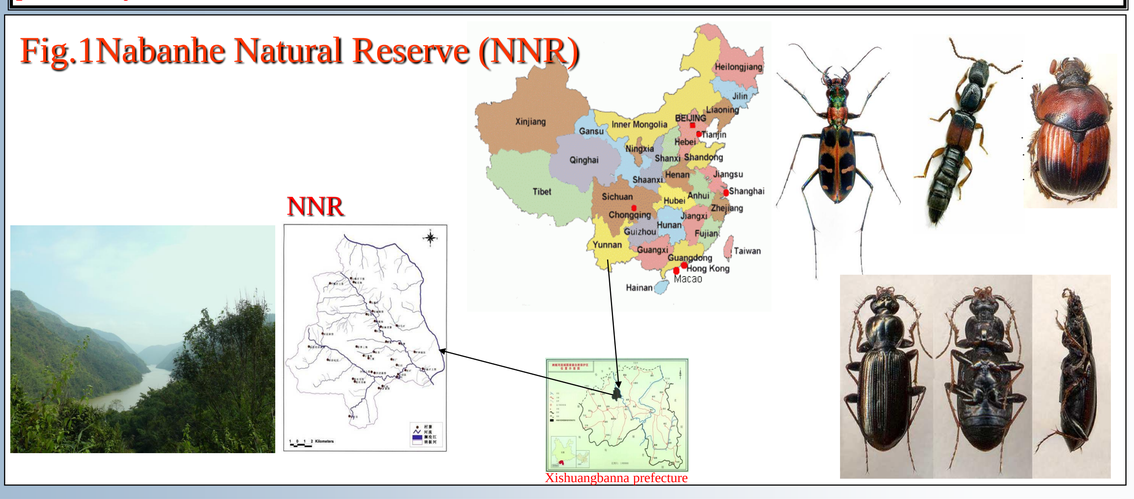
Hypothesis:

(1)The population of beetles in the study area is affected negatively by the distance with the nearest fragmented forest;

(2)The number of beetles individual decreased with the age of rubber plantation;

(3)Compared with the site factor, micro-habitat influenced the abundance of beetles more profoundly.

Fig.1Nabanhe Natural Reserve (NNR)



STUDY AREA AND METHODS

STUDY AREA

Location

This study was conducted in the Nabanhe Natural Reserve (NNR), Xishuangbanna Prefecture, Yunnan province, SW China, latitude 22°04′~22°17′N and longitudes 100°32′~100° 44′ E is located on the north central of Xishuangbanna Prefecture and covered an area of 266.60km^2.Its altitude ranges from 539m to 2304m above sea level with the lowest place in Mandian and the highest place in Laguma. The region has mountain-valley topography and about 95% of the region is covered by mountains and hill.(See Fig.1)

Climate

Climate is belong to the moist type of north tropic and influenced by warm-wet air masses from the Indian Ocean in summer, including monsoons, and continental air masses of subtropical origin in winter, resulting in a rainy season from may to October, and a dry season from November to April(Zhang,1988), mean annual temperature ranges between 18 ℃ and 22℃,and annual rainfall ranges from 1193mm to 2491mm with the most of it concentrated in the rainy season.

Tab.1 Brief information of study sites and habitats

Site	Latitude & longitude	Altitude(m)	Age(years)			Distance to Forest (m)		
			Forest	Rubber	Open land	Forest	Rubber	Open land
Mandian	22°06′N, 100° 35′ E	590	#	4	30	0	150	300
Naban	22°08′N, 100° 40′ E	820	#	10	3	0	50	10
ADZ	22°09′N, 100° 37′ E	990	#	25	10	0	600	700

represents did not get data temporary and ADZ represents Anmaxinzhai.

METHODS

Sampling of Beetles

We conducted field work during 2008 from the end of April to the middle of July just at the end of the dry season and the beginning of rainy season. We set pitfall trap in 3 different sites (Mandian, Naban and Anmaxinzhai) with 3 different habitats (fragmented forest, rubber plantation and Open land) .5 plastic cups filled with one-third volume of 25 percentage of formaldehyde were set up in each sampling habitats to prevent the escape of beetles and body rotten. The caliber of plastics cup is about 10 cm and buried within soil and make the rim of cup has the same level with ground more or less. Then we collected the sample in cup from every 10 to 15 days with the replace of liquid within the trap cup.

Data analysis

Since sampling effort (number of pitfall, times of sampling) was the same across sampling sites and habitats, we compared the individual number of beetles across sites and habitats using total and percentage with the time series to find the major beetles group in the samplings. Using the statistics to check the site and habitat factor influence the distribution and abundance dynamics of beetles group. When compare the sites factor, we combined the data of 3 different habitats together after compared each other respectively and it's same to habitats factor. Mean and standard deviations (±SD) or averages are given throughout the paper.

Non-parametric tests were used for statistical comparisons (Fitch 1992), and Sigmaplot 9.0 were used for draw the figs.

RESULTS

(1) Totally, we collected the 2530 individuals of different beetles group in 3 different sites ,Mandian, Naban and Anmaxinzhai(ADZ) with 3 different micro-habitats (See Tab.2). Dung beetles have 1264 individuals with the percentage of 49.96% is the largest group among them, another 4 major groups are rove beetles, tiger beetles, bark beetles and ground beetles with the percentage of 16.04%(406),9.45% (239),8.02%(203) and 7.35%(186) respectively. Dung beetles have the largest amounts of individuals in total 3 habitats of Naban and ADZ, but not for Mandian. Other groups have the different distribution specifics in different habitats of different sites.

(2)Gennearlly, the abundance of beetles group in 3 different habitats of 3 different sites decreased obviously with the coming of rainy season (See Fig.2) except the habitats of rubber plantation in Mandian and Anmaxinzhai(ADZ) and have the lowest abundance in the last time of sampling among total.

(3) There is a significantly difference of species abundance among 3 habitats in Anmaxinzhai but not for Mandian and Naban (See Fig.3), and habitat effects on the beetles group on fragmented forest of 3 different sites significantly (See Tab.3).Linked the brief information with 3 different habitats of 3 sites(Tab.1), we can get a conclusion that variation of beetles species abundance increased with the distance to forest and age of habitat shaping.

Fig.2 Abundance dynamic in Mandian,Naban and Anmaxinzhai(ADZ) from left to right in turn

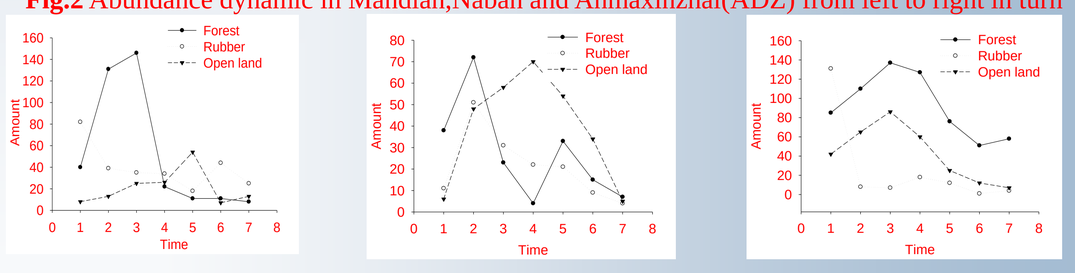
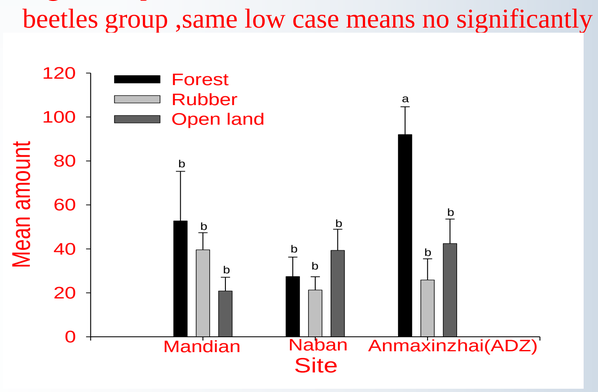


Fig.3 Compare the site and habitat effects on the abundance of beetles group ,same low case means no significantly difference



Tab.2 Number of individual collected

Site	Habitat		
	Forest	Rubber	Open
Mandian	369	277	146
Naban	192	149	275
ADZ	644	181	297
Total		2530	

Tab.3 Statistics results of habitats and site effects on the richness and abundance of beetles group

	Mandian				Naban				Anmaxinzhai(ADZ)				Combined	
Habitat	Richness		Abundance		Richness		Abundance		Richness		Abundance		Abundance	
	F	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
	2.24	0.14	1.26	0.31	1.39	0.28	1.21	0.32	8.84	0.002**	5.97	0.01*	2.85	0.08
Site	Forest				Rubber plantation				Open land				Combined	
	Richness		Abundance		Richness		Abundance		Richness		Abundance		Abundance	
	F	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
	9.28	0.002**	4.25	0.03*	2.99	0.08	0.66	0.53	1.31	0.29	1.60	0.23	2.27	0.13

** $P<0.01$; * $P<0.05$

DISSCUSSIONS

It is no surprise that rapid expansion of rubber plantation has taken shape a lot of various micro-habitats with the destroy of rainforest vegetation in NNR which effects on beetles group sharply. With the forest area decreased, the beetles group in which lived are dependent on nearby areas for colonists. Our research find the habitats with the longer distance to nearest forest have the more significant abundance difference compared with forest, this is the same with the research of dung beetles in Alter do Chão,Amazŏnia of Brazil (Vulinec, *et al*.., 2008). In general, the majority of studies examined in a meta-analysis have found a decrease in species richness and diversity with fragmented forest size (Nichols, *et al*., 2007), however ,we found in the smallest fragmented forest have a high abundance of species distribution. Some studies have indicated a decrease in species richness with recently created habitats age (Larsen, *et al*., 2005), our research also showed the same regulations.

Site and habitats have the different effects on the beetles group in our research which showed fragmented forest have the various abundance but not for rubber plantation and open land in 3 different site, this maybe correlated with the disturbance intensity of forest. Compared with the site effects, 3 different micro-habitats in Anmaxinzhai (ADZ) has a significant difference among them but not in Mandian and Naban, this should influenced by the distance from the forest to rubber plantation and open land and it's also reflected the importance of age and history of micro- habitat.

In NNR, the influence took by the rapid land-use changing is still unknown precised and needs long time monitoring and evaluation Maybe we can get a balance between the profits of rubber plantation and conservation for biodiversity through a integrated maintenance and management with local agriculture eco-system.

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