ORIGINAL ARTICLE

Composition of canopy ants (Hymenoptera: Formicidae) at Ton Nga Chang Wildlife Sanctuary, Songkhla Province, Thailand

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Abstract

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Composition of canopy ants (Hymenoptera: Formicidae) at Ton Nga Chang Wildlife Sanctuary, Songkhla Province, Thailand
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Canopy ants were examined in terms of a number of species and species composition between in high and low disturbance sites of lowland tropical rainforest at Ton Nga Chang Wildlife Sanctuary, Songkhla province, Thailand, from November 2001 to November 2002. A permanent plot of 100x100 m^2 was set up and divided into 100 sub-units (10x10m^2) on each study site. Pyrethroid fogging was two monthly applied to collect ants on three trees at random in a permanent plot. A total of 118 morphospecies in 29 genera belonging to six subfamilies were identified. The Formicinae subfamily found the highest species numbers (64 species) followed by Myrmicinae (32 species), Pseudomyrmecinae (10 species), Ponerinae (6 species), Dolichoderinae (5 species) and Aenictinae (1 species). Myrmicinae and Ponerinae showed a significant difference of mean species number between sites ($P<0.05$) while Formicinae and Myrmicinae also showed a significant difference of mean species number between months ($P<0.05$). However, there were no interactions between sites and months in any subfamily.

Key words : ants, canopy, species composition, distrubance, Songkhla, Thailand

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องค์ประกอบของมดบนร่มไม้ (Hymenoptera: Fromicidae) ในเขตรักษาพันธุ์สัตว์ป่าโตนงาช้าง จังหวัดสงขลา ประเทศไทย

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ทำการศึกษาจำนวนชนิดและองค์ประกอบของมดระหว่างพื้นที่ป่าที่ถูกรบกวนสูงและพื้นที่ป่าที่ถูกรบกวนน้อยของป่าดิบชื้นระดับต่ำในเขตรักษาพันธุ์สัตว์ป่าโตนงาช้าง จังหวัดสงขลา ประเทศไทย ระหว่างเดือนพฤศจิกายน 2544-พฤศจิกายน 2545 โดยทำการวางแปลงฉวารขนาด 100x100 ตร.เมตร จำนวน 2 แปลง แล้วแบ่งเป็นแปลงย่อยอีก 100 แปลง (10x10 ตร.เมตร) ของแต่ละพื้นที่ศึกษา ทำการเก็บตัวอย่างมดบนเรือนยอดไม้ทุก ๆ 2 เดือน ด้วยวิธีการฉีดพ่นยาฆ่าแมลงประเภทไพรีทรอยด์ไปยังร่มไม้ โดยแต่ละครั้งของการเก็บตัวอย่างทำการสุ่มพื้นที่แปลงย่อยมาอย่างละ 3 แปลงของแต่ละพื้นที่ ซึ่งแปลงย่อยที่สุ่มแล้วจะไม่มีการซ้ำในครั้งถัดมา ผลการศึกษาพบมดบนเรือนยอดทั้งหมด 118 ชนิดใน 29 สกุล ของ 6 วงศ์ย่อย วงศ์ย่อยที่พบจำนวนชนิดสูงสุดคือ Fomicinae (64 ชนิด) รองลงมา Myrmicinae (32 ชนิด) Pseudomyrmecinae (10 ชนิด) Ponerinae (6 ชนิด) Dolichoderinae (5 ชนิด) และ Aenictinae (1 ชนิด) สำหรับพื้นที่ป่ามีผลต่อองค์ประกอบของชนิดมดในวงศ์ย่อย Myrmicinae และ Ponerinae อย่างมีนัยสำคัญทางสถิติ ($P<0.05$) ในขณะที่เดือนที่ทำการศึกษามีผลต่อองค์ประกอบของชนิดมดในวงศ์ย่อย Formicinae และ Myrmicinae อย่างมีนัยสำคัญทางสถิติ ($P<0.05$) ส่วนพื้นที่ศึกษากับเดือนที่ศึกษาไม่มีอันตกริยาต่อกันขององค์ประกอบของชนิดมดในแต่วงศ์ย่อย

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Arthropods have a great diversity in every tropical rainforest canopy e.g. over 3,000 arthropod species from Bornean lowland rainforest trees (Stork, 1991), over 170 arthropod families in primary forest in New Caledonia (Guilbert, 1997), more than 900 beetles species in Venezuelan rainforest tree canopies (Davies *et al*., 1997) and more than 150 ants species in Budongo forest of the Uganda (Schulz and Wagner, 2002).

Ants are one group of arthropods belonging to class Insecta (Borror *et al*., 1989). They play an important role in maintaining the natural balance of ecosystem and they can be used as an indicator of environmental changes (Maryati, 1997; Peck *et al*., 1998, Toda and Kitching, 1999). They are widely distributed in tropical rainforest. In addition, in the canopies, individual numbers and total biomass of ants are higher than other arthropods (Watanabe and Ruaysoongnern, 1989; Holloway and Stork, 1991; Guilbert, 1997). There are few studies that have identified individuals collected to species level (e.g. Wilson, 1987; Majer, 1990; Floren and Linsenmair, 1997 and Harada and Adis, 1997). Thailand also has few studies of canopy ants when compared with the terrestrial species (e.g. Watanasit *et al*., 2000; Prasityousil, 2001 and Phoonjumpa, 2002).

Many factors influence the diversity of arthropods (Didham and Springate, 2003). There are a few studies on the effect of study sites and temporal change on diversity of insects in this region. In Thailand study sites affect the diversity of canopy beetles at Klong Seang Wildlife Sanctuary (Dumluk, 1998) and at Ton Nga Chang Wildlife Sanctuary (Watanasit *et al*., 2004). Moreover the study sites influence the diversity of butterflies in Bornean rainforest (Willott *et al*., 2000) and the diversity of geometrid moths in Peninsular Malaysia (Intachat *et al*., 1999). Watanasit and Noon-anant (2005) found that study sites also have an impact on the diversity of understorey ant at Ton Nga Chang Wildlife Sanctuary.

Hence, these studies indicated that study sites have an effect on diversity of insects.

Although the tropical rainforest area provides an aseasonal climate, diversity of insects still changes along the time of the year. For instance, Boonvano *et al*. (2000) found that the monthly diversity of butterfly in southern Thailand was the highest diversity in February and the lowest in September and also Watanasit *et al*. (2004) found that the canopy beetles diversity differed among months of the year. However, there is no sign of seasonality in the ant (Watanasit and Noon-anant, 2005).

Thus the present study aims to examine the number of ant species and species composition of canopy ants and also compare species-richness by study site and month at Ton Nga Chang wildlife sanctuary. At least this study will provide a good database on the canopy ants in the region and more research will be carried out in Thailand.

Materials and Methods

Study area

Field work was carried out at Ton Nga Chang Wildlife Sanctuary, which is located in southern Thailand in a mountainous section of Songkhla and Satun provinces (longitude 6º 5' - 7º 3' N; latitude 100º 8' - 100º 16' E) (Figure 1); 82% is tropical rainforest covering the Bantad mountain

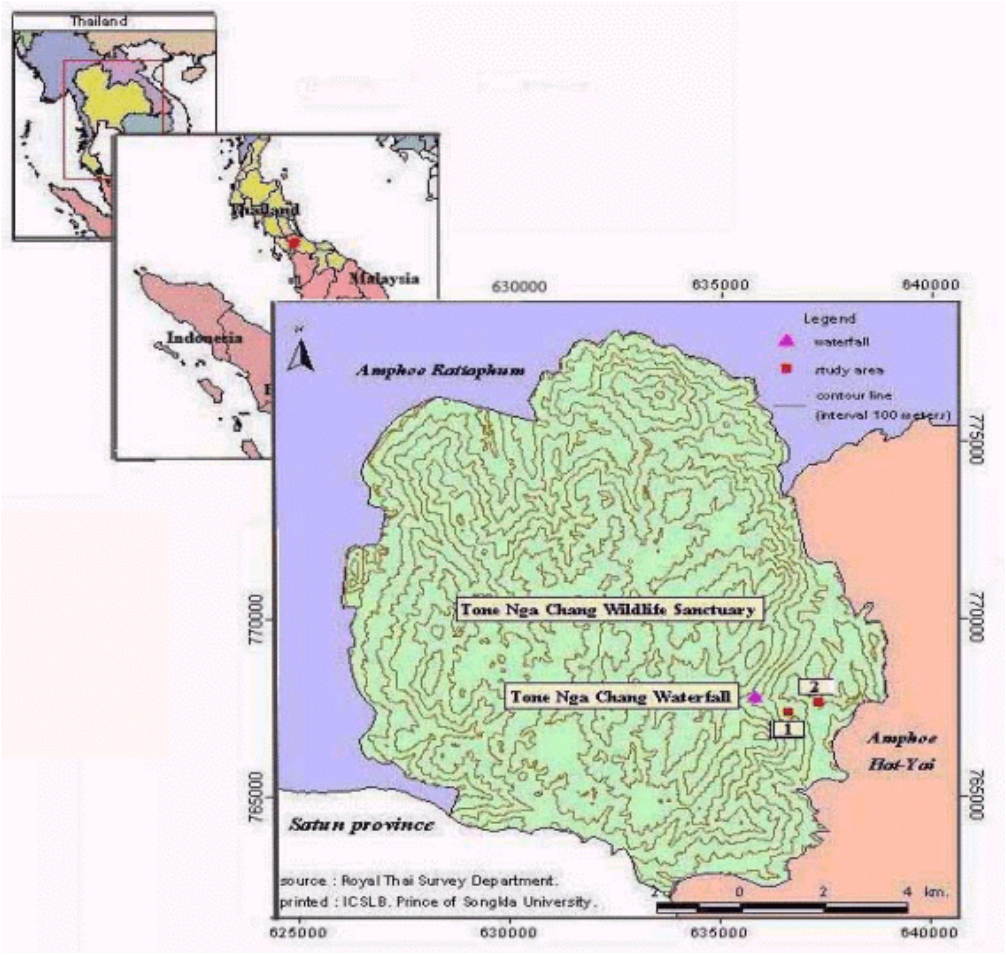

Figure 1. Study sites at Ton Nga Chang Wildlife Sanctuary [1], low disturbance site, [2], high disturbance site.

Table 1. Weather conditions during sampling months at Ton Nga Chang Wildlife Sanctuary (data supported by Meteorological Station at Hat Yai International Airport)

Month - year	Mean temperature (ºC)	Humidity (%)	Rainfall (mm)
Nov-01	26.3	85.6	126
Jan-02	26.1	80.2	2.1
Mar-02	28.3	75.3	35.7
May-02	28.4	79	102.4
Jul-02	28.1	76.1	40.3
Sep-02	27.1	78.4	33
Nov-02	26.5	86.2	275.4

range. It can be divided into three area types by height above sea level, lowland tropical rainforest (<300 m above sea level), upper tropical rainforest (300-750 m above sea level) and hill evergreen rainforest (>750 m above sea level).

The average monthly temperature at Ton Nga Chang Wildlife Sanctuary during the sampling period was relatively stable; the humidity was constantly higher than 70% every month and rainfall showed high fluctuation (Table 1).

Sampling procedures

Canopy ants were collected at two sites in lowland tropical rain forest, Ton Nga Chang Wildlife Sanctuary. One site is located near Ton Nga Chang Waterfall. The characteristics of this site are dense forest, high continuity of canopy and low human activities. It was defined as a low disturbance site. Another site is located in a natural arboretum. The characteristics of this site are low density forest, less continuity of canopy and high human activities. It was defined as a high disturbance site.

Each site was established in a permanent plot of 100x100 m^2 .The plot was divided into 100 small quadrates of 10x10 m^2. Every two months (November 2001 - November 2002), three randomly selected small quadrates (non-repeated sampling) were sampled. Using 10 umbrella bags (2 m^2/umbrella bag) and fogging equipment (SWINFOG® model SN 50) which were hauled to the canopies. The pyrathoid insecticide was mixed with diesel in the ratio of 1:49 and was fogged into the canopies (15-30 m height) in the morning about 6.00 am for 20 minutes/tree (Figure 2). After 2 hours, fallen ants were collected and they were

Figure 2. Insecticide fogging and umbrella bags, applied for collecting ants on tree canopies.

Ant identification and data analysis

immediately preserved in 70% alcohol.

Hölldobler and Wilson (1990) and Bolton (1994) were used for identification to the genus level. *Polyrhachis* morphospecies were confirmed by Dr.Rudolf J. Kohoult from Queensland Museum, Australia and the others were compared with the specimens at Ant Museum, Kasetsart University, Bangkok.

Analysis of variance (two-way ANOVA) was applied to compare between mean numbers of species in each subfamily and study sites and months. Calculations were performed on SPSS for Windows version 10.

Results

Species-rich and composition

With insecticide fogging, a total of 118 morphospecies in 29 genera belonging to 6 subfamilies were captured and identified. The most

Table 2. Numbers and percentages of ant species found in canopy trees at Ton Nga Chang Wildlife Sanctuary.

Subfamily	genus	No. of species	Proportion in %
Aenictinae	*Aenictus*	1	0.85
Dolichoderinae	*Dolichoderus*	2	1.69
	Philidris	2	1.69
	Technomyrmex	1	0.85
Formicinae	*Camponotus*	26	22.03
	Echinopla	5	4.24
	Gesomyrmex	1	0.85
	Oecophylla	1	0.85
	Paratrechina	1	0.85
	Polyrhachis	28	23.73
	Prenolepis	2	1.69
Myrmicinae	*Cataulacus*	1	0.85
	Crematogaster	11	9.32
	Dilobocondyla	1	0.85
	Leptothorax	3	2.54
	Meranoplus	2	1.69
	Myrmicaria	1	0.85
	Paratopula	3	2.54
	Pheidole	1	0.85
	Pheidologeton	1	0.85
	Rhopalomastix	1	0.85
	Tetramorium	4	3.39
	Vollenhovia	3	2.54
Ponerinae	*Anochetus*	1	0.85
	Diacamma	1	0.85
	Platythyrea	2	1.69
	Odontomachus	1	0.85
	Odontoponera	1	0.85
Pseudomyrmecinae	*Tetraponera*	10	8.47
Total	29	118	100

diverse subfamilies were Formicinae (64 species) followed by Myrmicinae (32 species), Pseudomyrmecinae (10 species), Ponerinae (6 species), Dolichoderinae (5 species) and Aenictinae (1 species). Genus *Polyrhachis, Camponotus, Crematogaster* and *Tetraponera* showed high species diversity whereas other genera comprised 1-5 species (Table 2)

Table 3. Mean (±se) species number of ants in each subfamily at high and low disturbance sites at Ton Nga Chang Wildlife Sanctuary during November 01 - November 02.

Taxa	Low distrubance site							High distrubance site						
	Nov01	Jan02	Mar02	May02	Jul02	Sep02	Nov02	Nov01	Jan02	Mar02	May02	Jul02	Sep02	Nov02
Aenictinae	0.33±0.33	0	0	0	0	0	0	0	0	0	0	0	0	0
Dolichoderinae	1.33±0.67	0.67±0.33	2.00±0.00	0.67±0.67	1.00±0.00	2.67±0.33	1.33±0.67	0.67±0.33	0.67±0.33	1.33±0.33	1.67±0.67	1.33±0.33	1.33±0.33	1.00±0.00
Formicinae	5.67±1.20	4.67±1.45	8.33±0.67	4.00±1.53	11.67±0.33	7.00±1.53	8.67±0.88	3.67±0.33	6.67±3.29	6.00±2.08	5.67±0.67	12.67±1.45	9.33±2.41	5.33±0.33
Myrmicinae	1.33±0.33	0.67±0.33	4.00±1.00	3.00±1.53	4.67±1.33	2.67±1.20	4.67±0.33	1.33±0.33	1.00±1.00	3.33±1.20	1.33±0.33	2.33±0.67	1.67±0.33	2.00±0.58
Ponerinae	0	0.33±0.33	0.67±0.33	0.33±0.33	0	0.67±0.67	0.33±0.33	0	0	0	0	0	0	0
Pseudomymicinae	0.67±0.33	1.00	0.67±0.67	1.00±0.58	1.67±0.88	1.00	1.33±0.33	0.33±0.33	0.67±0.33	1.33±0.33	1.00±0.58	2.00±1.16	1.33±0.33	0.33±0.33

Comparison of species-rich

There were two subfamilies that were found only in the low disturbance site, Ponerinae and Aenictinae, and their mean species number were low. Compare between the mean number of ant species in each subfamily and study sites and months is shown in Table 3.

Analysis of variance (two-way ANOVA) showed a significant difference in mean species number of subfamilies Myrmicinae and Ponerinae between study sites ($P<0.05$). Moreover mean species number of subfamilies Myrmicinae and Formicinae showed a significant difference between months ($P<0.05$). Tukey's Multiple Comparison test showed that the mean species number of subfamilies Formicinae in July 2002 was significantly different from those in November 2001, January and May 2002 whereas mean species number of subfamilies Myrmicinae in January 2002 differed significantly from those in March, July and November 2002. However there was no significant interaction between site and month (Table 4).

Discussion

Species-rich and composition of canopy ants

The number of species shown in this study was less than the species number in other tropical rain forests i.e. 135 species in 40 genera at Tempbopata Reserved (Wilson, 1987), 218 species from seven subfamilies at primary rainforest in Sabah (Floren and Linsenmair, 1997) and 161 species from 30 genera at Bodongo Forest (Schulz and Wagner, 2002). The reason may involve in the difference of habitats, experimental design and sampling techniques. Those three previous studies

covered microhabitats and a high variety of plants in primary rain forest, which mainly aimed to investigate the diversity of the canopy ants while the present study was studied in the secondary rain forest and the microhabitats covered only two hectares. Moreover, the present study aimed not only to investigate the species diversity, but also aimed to study their ecological distributions. Therefore, the experiments had to be designed to support more questions in ecology. In addition the insecticide fogging technique also has a weak point, it cannot capture the cryptic ants or insects in the hollows or the trunks of trees (Stork and Hammond, 1997). Furthermore, the number and position of the collecting containers can also affect the species collected.

The ant composition of the present study was similar to that in a study in Borneo Island (Floren and Linsenmair, 1997). It may be because of their biogeographical distribution, the similarity of plant composition and the evolutionary history of canopy ants (Hölldobler and Wilson, 1990; Bolton, 1995; Brühl *et al*., 1998).

Using canopy ants as the indicator of environmental change

There are few studies on the use of canopy ants as an indicator of environmental change. Lawton *et al*. (1998) indicated that the more logging plants, the lower the number of canopy ants. In contrast to the present study which found a higher number of ants in more disturbed areas i.e. there are more number of Myrmicinae and Ponerinae at the high disturbance area. These two subfamilies comprise of several ground-dwelling genera i.e. *Diacamma, Odontomachus* and *Pheidole* (Brown, 2000; Euchi, 2001). It was suggested that the changing of forest structure by human activities such as logging of lowering vegetation can change the community structure of canopy ants. Thus in disturbed areas terrestrial ants may travel from the ground and canopy ants may travel to the ground.

The numbers of species in each subfamily were significantly different between months into two subfamilies, Formicinae and Myrmicinae (Table 4) and the number of species generally tended to increase in the dry months and tended to decrease in the wet months (Table 1 and Table 3). These numbers are consistent with their food supply i.e. nectar and fruit saps from flowering plants (Tobin, 1995) which were found to be high in dry months (Smith, 1996), coinciding with foraging activity which was also high in this period.

Table 4. Analysis of variance (two-way ANOVA) showing the F-value and significant level of the mean number in each subfamily at Ton Nga Chang Wildlife Sanctuary (* = P<0.05, ns = non significant and degree of freedom in parenthesis).

Family	Source of variance		
	Site(1)	Month(6)	Site x month(6)
Aenictinae	1.00 ns	1.00 ns	1.00 ns
Dolichoderinae	0.18 ns	1.78 ns	1.16 ns
Formicinae	0.10 ns	4.44*	1.20 ns
Myrmicinae	4.57*	4.14*	0.50 ns
Ponerinae	6.66*	0.59 ns	0.59 ns
Pseudomyrmicinae	0.15 ns	0.76 ns	0.78 ns

Note: Data was transformed to a log (x+1). Variance were not homogeneous (P<0.05).

The perspectives of the research on canopy ants and canopy arthropod in Thailand

In Thailand, the studies on the taxonomy and ecology of ants and other insects in the canopy are still needed. This basic knowledge will enable us to know more about the relationships and interactions between ants and plants, then they can be used as bio-indicators and biological control. Moreover, they can be applied for food or medicinal resources in the future.

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