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*Original Article*

# Diversity and ecology of ground dwelling ants at Khao Nan National Park, southern Thailand

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**Abstract**

Khao Nan National Park (KNNP) is located in the southern part of Thailand. Its flora and fauna are diverse, however there is little information about the diversity of ants. The aim of this study was to determine species diversity and ecology of ants at KNNP. Three study sites (Baucheak Trail, Pra Forest and Sunantha Trail) were chosen and at each three permanent plots of 30x30 m were selected at least 500 m apart. The ant sampling was extracted from leaf litter by the Winkler bag method. Physical factors of precipitation, humidity, air temperature, and soil temperature were recorded during the collection of ants every two months between January 2006 and January 2007. A total number of 172 species and 43 genera belonging to 9 subfamilies were identified. The top five dominant genera of ants were *Pheidole* (27 species) following by *Tetramorium* (14 species), *Camponotus* (13 species), *Pachycondyla* (12 species), and *Crematogaster* (9 species). The influence of the study sites on the species number of ants in this study indicated that the study sites had an affect on the species number. Regarding the environmental factors, the results showed that the individual numbers of *Pheidole* was significantly negatively correlated to precipitation, whereas *Pachycondyla* was significantly negatively correlated to humidity, while both genera were significantly positively correlated to air temperature and soil temperature. Moreover, *Camponotus* was the only genus significantly positively correlated to the air temperature.

**Keywords:** diversity, ecology, ground dwelling ant, southern Thailand

## 1. Introduction

Khao Nan National Park is a part of the Nakhon Si Thammarat mountain range in southern Thailand. The total area is 436 km$^2$ with elevation above sea level ranging from 100-1,400 m. The park is covered with tropical rain forest and cloud forest. The topography of the park is dominated by basalt rocks and a mixture of limestone, sand and shale. The National Park is located in the Tropical Zone with rather constant temperature and rainfall throughout the year. There are only two seasons, wet and dry. Heavy rain is during May-September (Wittaya, 2000). Fauna and flora are diverse but there is little data about ants in the National Park.

Ants are important not only because of their diversity (Alonso *et al*., 2000) but also because of their being a functional part of the ecosystem, turning forest soil, dispersing seeds and helping with decomposition (Maryati, 1997).

The diversity of ants depends on many factors, both biotic and abiotic, such as elevation (Samson *et al*., 1997), vegetation type (Wilson, 1958; Bestelmeyer and Wiens, 2001), predation (Kaspari, 1996b), temperature (Bestelmeyer, 2000), humidity (Kaspai, 1996a), sampling methods (Watanasit, 2003; Noon-anant *et al*., 2005; Watanasit *et al*., 2007) and habitat preferences of the ants (Watanasit *et al*, 2003). Thus, the aims of this study were to examine the diversity and abundance of the ants in relationship to study sites and environmental factors.

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## 2. Material and Methods

### 2.1 Study sites

The study was conducted at Khao Nan National Park located in Nakhon Si Thammarat Province, southern Thailand (Figure 1). Three study areas were selected, namely, Baucheak Trail, Pra Forest and Sunantha Trail.

Site 1 is Baucheak Trail (BC), is located at 8° 46'N and 99° 47'E. This study site is at 280-420 m above mean sea level, with a very high slope, and thin soil surface. The vegetation is composed of *Syzygium gratum* (Wight) var. *gratum*, *Lithocarpus* sp., *Nageia* sp., *Gnetum* sp., *Magnolia elegans* (Blume), *Hopea odolata* Roxb., *Dipterocarpus kerril* King, *Livistona speciosa* Kurz. The understorey and ground cover includes *Rhododendron moulmeinense* Hook., *Vaccinium bracteatum* Thunb, *Calamus* spp., *Dinochloa scandens* (Blume), *Coelogyne* spp., *Eria* spp., *Bulbophyllum patens* King, *Bromheadia alticola* Ridi, *Dipteris conjugate* Reinw, and *Dicranopteris linearis* (Burm.) var. *linearis*.

Site 2 Pra Forest (PF) is located at 8° 51'N and 99° 37'E. This study site is at 130-350 m above mean sea level. The dominant vegetation is *Elateriospermam tapos* Blum, which local people call Pra Forest. The understorey and ground cover includes *Eurycoma* sp., *Ardisis* sp, *Calamus* spp., *Lasianthus* sp., *Diospyros* sp., *Tectaria* sp., and *Nepholepis* sp.

Site 3 Sunantha Trail (ST) is located at 8° 46'N and 99° 48'E. This study site is at 140-160 m above mean sea level. It is a valley with steep hills. The vegetation is composed of *Ficus* sp., *Caryota* sp., *Diospyros* sp., *Syzygium* sp., and *Mangifera* sp. The understorey and ground cover includes *Greenea* sp *Lasianthus* sp., *Ardisia* sp., *Amomum* sp. *Lygodium* sp. and *Tanitis* sp.

### 2.2 Sampling procedures

Three permanent plots of 30 X 30 m were set up at each study site, providing nine permanent plots. From each plot, leaf litter and soil detritus were collected in a quadrat of 1 X 1 m for 3 samplings. Thus, the total number of samplings are nine in each study site. This study was conducted every 2 months during January 2006-January 2007. The litter were sifted using a litter sifter and the sifted material was then kept inside a Winkler sack for 2 days. All material collected from the Winkler extraction was then removed and stored in 80% ethyl alcohol.

The physical data at the sites, precipitation, humidity, air temperature, and soil temperature were recorded at the sampling times.

### 2.3 Preservation and identification

All ants were brought back to the Department of Biology, Faculty of Science, Prince of Songkla University, for separating them from invertebrate material and pinning for further identification.

Bolton (1994; 1995; 2003) were used to identify ants to the genus level. Provisional species-level identifications were confirmed by Prof. Seiki Yamane, Kagoshima University, Japan. The voucher collection of ants is maintained at the Princess Maha Chakri Sirindhorn National History Museum, Prince of Songkla University, Hat Yai, Songkhla Province, Thailand.

### 2.4 Analysis

One-way ANOVA was used to compare the mean values of the number of ant species. Calculations were

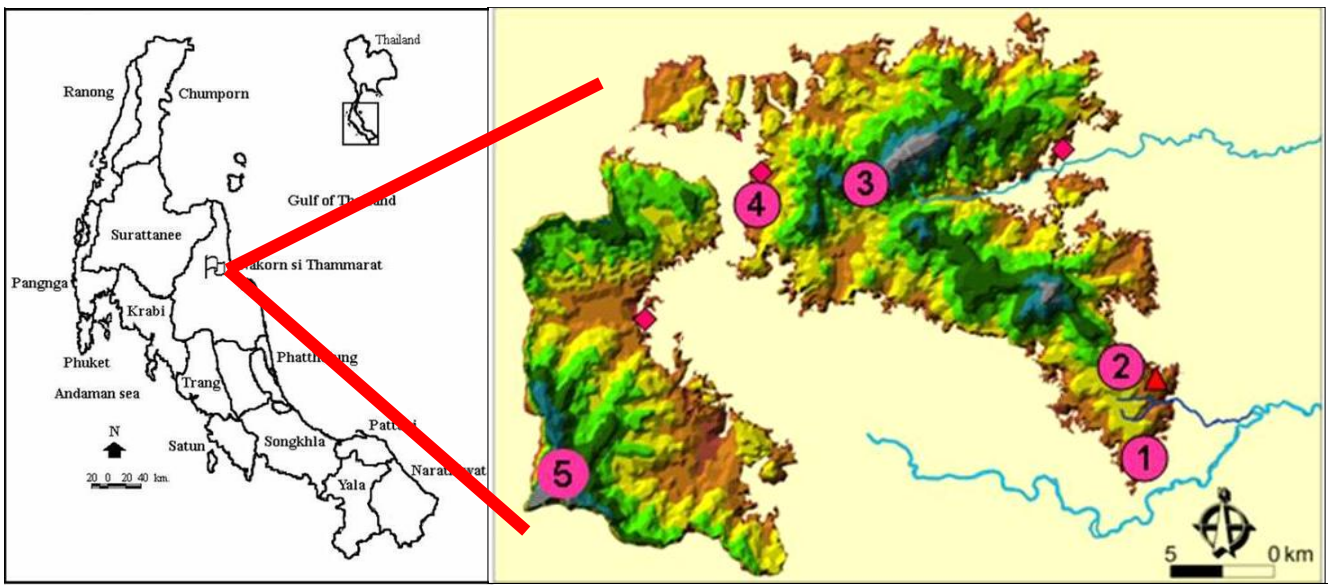


Figure 1. Map and location of the study sites at KNNP (1 = Baucheak Trail, 2 = Sunantha Trail and 4 = Pra Forest).

performed on SPSS for Windows version 11. Spearman rank correlation coefficients between physical factors and individual numbers of ants in each genera was also computed using SPSS for Windows version 11.

## 3. Results

### 3.1 Diversity of ants

Nine subfamilies, 43 genera, and 172 species of ants were identified from KNNP between January 2006 and January 2007. The number of ant genera and species is shown in Table 1. The top five dominant genera of ants was *Pheidole* (27 species) following by *Tetramorium* (14 species), *Camponotus* (13 species), *Pachycondyla* (12 species), and *Crematogaster* (9 species).

### 3.2 Effect of study sites

The mean values of the number of ant species were compared among the study sites. It showed that the study site had an influence on the number of ant species (ANOVA, F-value = 17.83, P = 0.000, Table 2).

### 3.3 Correlation with physical factors

The spearman rank correlation among physical factors and individual numbers of the top five genera are shown in Table 3. It indicated that the individual number of *Pheidole* had a significant negative correlation to precipitation and the individual number of *Pachycondyla* had a significant negative correlation to humidity, while there was a significant positive correlation to air temperature and soil temperature of both genera. Moreover, *Camponotus* was the only ant genera that had a significant positive correlation to air temperature.

## 4. Discussion

### 4.1 Diversity of ants

A total of nine subfamilies, 43 genera, and 172 species of ant were collected from KNNP by the Winkler bag method. It indicated that the diversity of ants is quite high, because it has been estimated that there are about 800-1,000 species of ants in Thailand (Wiwatwitaya, 2003). The ants in KNNP therefore represent about 17 -21% of this estimated total. The diversity of ants increases with a combination of collecting methods (Watanasit, 2003; Noon-anant *et al*., 2005), thus ant diversity of KNNP in this study is underestimated because we used only one collection method.

The most species (83) were in the subfamily Myrmicinae, followed by Formicinae (37 species) (Table 1). These findings are similar to many previous studies in Thailand (Watanasit *et al.*, 2003; Watanasit and Noon-anant, 2005; Watanasit *et al*., 2007).

At the genus level, the top five were *Pheidole, Tetramorium, Camponotus, Pachycondyla* and *Crematogaster*. The *Pheidole, Tetramorium* and *Crematogaster* belong to the subfamily Myrmicinae, while *Camponotus* and *Pachycondyla* belong to the subfamily Formicinae and Ponerinae, respectively. The *Pheidole, Tetramorium* and *Pachycondyla* are dwelling ants that inhabit the soil, under rotten wood on the ground (Shattuck, 1999; Brown, 2000; Eguchi, 2001). Moreover, the *Camponotus* of some species can build their nest in the ground (Brown, 2000). Thus, it is not surprising why the winkler bag method is suitable for collecting ants from habitats on the ground floor. On the other hand, *Crematogaster* ants build their nests in hollow tree trunks and branches (Brown, 2000), it may be that they accidentally drop onto the ground or come to the ground to find food during the time ants are being sampled.

### 4.2 Study sites

In this study we found that the study sites have an effect on the numbers of ant species (Table 2). Many studies have supported the claim that the type of habitat influences species diversity in the insect group, such as for geometrid moths (Intachat *et al*., 1999; Beck *et al*., 2002), butterflies (Willott *et al*., 2000), beetles (Watanasit *et al*., 2004) and also ants (Watanasit *et al*., 2005; Watanasit *et al*., 2007). The type of vegetation can also play an important role in the diversity of ants (Wilson, 1958; Bestelmeyer, 2000). Pra Forest is unique among the three study sites because its vegetation type is dominated by *Elateriospermam tapos* Blum. It is a briefly deciduous plant that drops its leaves annually in February-March during the dry season (Whitmore, 1972; Osada *et al*., 2002).

### 4.3 Physical factors

There are only three genera, *Phiedole, Camponotus* and *Pachycondyla*, where the physical factors have an impact on individual numbers. The individual number of *Phielode* increases when the amount of precipitation is low, the number of *Pachycondyla* increases when humidity is also low, and the number of both genera increases when the air temperature and soil temperature is high. For the *Camponotus*, an increase of individual numbers correlates with a higher temperature of both air and soil. Usually when it rains the air and soil temperature decrease but it causes higher humidity. The rain can destroy the ants, which build their nests in the soil and on the ground, especially dwelling ants. Hölldobler and Wilson (1990) showed that rainfall (precipitation) could disturb the feeding behaviour of ants. They will not come out from their nest to forage after the rain has ceased. From our observation at days of heavy rain, there were only a few numbers of ants in the collecting samples. Thus, this study indicates that precipitation, humidity, and temperature may have an affect on the numbers of those ants.

Table 1. The number of genera and species of ants collected in each subfamily, found at the three study sites by the Winkler bag method at KNNP between January 2006 and January 2007.

| Subfamilies/Genera | Baucheak Trail | | Pra Forest | | Sunantha Trail | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Genera | Species | Genera | Species | Genera | Species | Genera | Species |
| **1. Aenictinae** | 1 | 1 | 1 | 1 | 1 | 1 | **1** | **2** |
| *Aenictus** | 1 | 1 | 1 | 1 | 1 | 1 | | 2 |
| **2. Cerapachyinae** | 0 | 0 | 1 | 2 | 0 | 0 | **1** | **2** |
| *Cerapachys* | 0 | 0 | 1 | 2 | 0 | 0 | | 2 |
| **3. Dolichoderinae** | 4 | 10 | 2 | 5 | 2 | 8 | **4** | **13** |
| *Dolichoderus* | 1 | 1 | 1 | 1 | 0 | 0 | | 2 |
| *Philidris* | 1 | 1 | 0 | 0 | 0 | 0 | | 1 |
| *Tapinoma* | 1 | 2 | 0 | 0 | 1 | 3 | | 3 |
| *Technomyrmex** | 1 | 6 | 1 | 4 | 1 | 5 | | 7 |
| **4. Dorylinae** | 1 | 1 | 0 | 0 | 1 | 1 | **1** | **1** |
| *Dorylus* | 1 | 1 | 0 | 0 | 1 | 1 | | 1 |
| **5. Ectatomminae** | 1 | 1 | 1 | 1 | 0 | 0 | **1** | **1** |
| *Gnamptogenys* | 1 | 1 | 1 | 1 | 0 | 0 | | 1 |
| **6. Formicinae** | 7 | 20 | 7 | 22 | 8 | 23 | **9** | **37** |
| *Acropyga* | 0 | 0 | 1 | 2 | 1 | 1 | | 2 |
| *Anoplolepis* | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| *Camponotus* | 1 | 7 | 1 | 8 | 1 | 9 | | 13 |
| *Echinopla* | 0 | 0 | 0 | 0 | 1 | 1 | | 1 |
| *Euprenolepis* | 1 | 1 | 1 | 1 | 0 | 0 | | 2 |
| *Oecophylla* | 1 | 1 | 0 | 0 | 1 | 1 | | 1 |
| *Paratrechina* | 1 | 4 | 1 | 5 | 1 | 3 | | 6 |
| *Polyrhachis* | 1 | 4 | 1 | 3 | 1 | 5 | | 8 |
| *Pseudolasiu* | 1 | 2 | 1 | 2 | 1 | 2 | | 3 |
| **7. Myrmicinae** | 9 | 42 | 13 | 52 | 14 | 43 | **16** | **83** |
| *Acanthomyrmex* | 0 | 0 | 1 | 1 | 0 | 0 | | 1 |
| *Cataulacus* | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| *Crematogaster* | 1 | 5 | 1 | 5 | 1 | 3 | | 9 |
| *Lophomyrmex* | 1 | 3 | 1 | 3 | 1 | 2 | | 4 |
| *Meranoplus* | 0 | 0 | 1 | 1 | 1 | 1 | | 1 |
| *Monomorium* | 1 | 4 | 1 | 4 | 1 | 4 | | 7 |
| *Oligomyrmex* | 0 | 0 | 1 | 2 | 1 | 2 | | 3 |
| *Pheidole* | 1 | 14 | 1 | 21 | 1 | 17 | | 27 |
| *Pheidologeton* | 0 | 0 | 0 | 0 | 1 | 1 | | 1 |
| *Pristomyrmex* | 1 | 2 | 1 | 2 | 1 | 2 | | 4 |
| *Recurvidris* | 0 | 0 | 0 | 0 | 1 | 1 | | 1 |
| *Rhoptromyrmex* | 0 | 0 | 0 | 0 | 1 | 1 | | 1 |
| *Solenopsis* | 1 | 2 | 1 | 2 | 1 | 1 | | 3 |
| *Strumigenys* | 1 | 2 | 1 | 2 | 1 | 2 | | 5 |
| *Tetramorium* | 1 | 9 | 1 | 7 | 1 | 5 | | 14 |
| *Vollenhovia* | 0 | 0 | 1 | 1 | 0 | 0 | | 1 |
| **8. Ponerinae** | 7 | 18 | 8 | 13 | 9 | 24 | **9** | **32** |
| *Anochetus* | 1 | 2 | 1 | 1 | 1 | 2 | | 3 |
| *Diacamma* | 0 | 0 | 1 | 1 | 0 | 0 | | 2 |
| *Emeryopone* | 0 | 0 | 0 | 0 | 1 | 1 | | 1 |
| *Hypoponera* | 1 | 3 | 1 | 2 | 1 | 2 | | 5 |
| *Leptogenys* | 1 | 1 | 1 | 1 | 1 | 1 | | 2 |
| *Odontomachus* | 1 | 2 | 1 | 1 | 1 | 2 | | 2 |
| *Odontoponera* | 1 | 2 | 1 | 3 | 1 | 2 | | 3 |
| *Pachycondyla* | 1 | 7 | 1 | 3 | 1 | 11 | | 12 |
| *Ponera* | 1 | 1 | 1 | 1 | 1 | 2 | | 2 |
| **9. Pseudomyrmecinae** | 1 | 1 | 0 | 0 | 1 | 1 | **1** | **1** |
| *Tetraponera* | 1 | 1 | 0 | 0 | 1 | 1 | | 1 |
| **Total** | 31 | 94 | 33 | 96 | 36 | 101 | **43** | **172** |

Table 2. Comparison of species numbers at the three study sites (Baucheak Trail, Pra Forest and Sunantha Trail) at KNNP.

a. Mean species number of ant (±SE) (untransformed and transformed data).

| Study sites | Number of species | | |
|---|---|---|---|
| | Mean (±SE) | Mean (logx+1) | N |
| BC (Baucheak Trail) | 8.81(±1.32) | 0.89 | 21 |
| PF (Pra Forest) | 17.76(±1.34) | 1.23 | 21 |
| ST (Sunantha Trail) | 19.81(±3.21) | 1.31 | 21 |

b. Analysis of variance.

| Source | df | Sum square | Mean square | F | P |
|---|---|---|---|---|---|
| Among group | 2 | 2.01 | 1.03 | 17.83 | 0.000 |
| Within group | 60 | 3.46 | 0.06 | | |
| Total | 62 | 5.51 | | | |

c. Multiple comparisons among group (Scheffe F-test).

| Comparison | Mean diff | F-test | P |
|---|---|---|---|
| BC vs PF | -0.34 | 14.05 | 0.001 |
| PF vs ST | -0.08 | 2.21 | 0.15 |
| ST vs BC | 0.42 | 32.38 | 0.000 |

Table 3. Spearman rank correlation coefficients (Cs) between physical factors of the top five genera of ants at KNNP during January 2006-January 2007.

| Genera | Precipitation (mm) | | Humidity (%) | | Air temp. (°C) | | Soil temp. (°C) | |
|---|---|---|---|---|---|---|---|---|
| | Cs | P | Cs | P | Cs | P | Cs | P |
| *Camponotus* | -0.10 | 0.42 | -0.02 | 0.87 | 0.29* | 0.02 | 0.20 | 0.11 |
| *Crematogaster* | -0.15 | 0.24 | -0.09 | 0.51 | 0.17 | 0.20 | 0.03 | 0.81 |
| *Pheidole* | -0.27* | 0.03 | -0.08 | 0.52 | 0.25* | 0.05 | 0.29* | 0.02 |
| *Tetramorium* | -0.19 | 0.14 | 0.04 | 0.75 | 0.08 | 0.56 | -0.17 | 0.18 |
| *Pachycondyla* | -0.24 | 0.06 | -0.28* | 0.03 | 0.43* | 0.001 | 0.41* | 0.001 |

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