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ANT (HYMENOPTERA: FORMICIDAE) OF THE KRAKATAUS, AND SEBESI AND SEBUKU ISLANDS

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Abstract

The ant fauna of the Krakataus, and Sebesi and Sebuku islands, based on collections made by RU in 2005 by intensive sweep-netting are reported. Thirty-seven species of ant were collected on the Krakataus (Rakata, Sertung, Panjang, and Anak Krakatau), 15 species on Sebesi, and 4 species on Sebuku. The ant species diversity on Anak Krakatau (20 species) was remarkably more diverse than those known from Rakata (15 species), Sertung (13 species), and Panjang (12 species). The ant species distribution on the Krakataus is discussed.

Key words: ants, Formicidae, sweep net, Krakataus, Sebuku, Sebesi, Indonesia

INTRODUCTION

The Krakatau islands, situated in the Sunda Straits, Indonesia, have experienced a series of eruptions, in particular highlighted by the historical explosions in August 1883. The 1883 huge eruptions resulted in the loss of over two thirds of the main island, Rakata, and it is likely that all the Krakatau islands were almost completely sterilized, without leaving any survived fauna and flora (Dammerman 1948, Thornton & Rosengren 1988). After the 1883 eruptions, studies on the recolonization of the islands by plants and animals have been done by several biologists (see Thornton & Rosengren 1988, Thornton 1996, Yamane 2005).

Among the fauna previously investigated, ants have got regarded as an interesting group in terms of species richness and recolonization process on the islands as they have an important function in tropical ecosystems. Ants, with their diversity and huge biomass, function as powerful predators in ecosystems and also as soil engineers, seed dispersers, and scavengers (Hölldobler & Wilson 1990). They are now also considered to be a useful indicator of biodiversity (Agosti *et al*. 2000). Ants of the Krakataus were first collected by Jacobson in 1908 and reported by Forel (1909). Later Dammerman made intensive surveys on the Krakatau fauna including ants (for a review, see Dammerman 1948). More recently Thornton & New (1988) gave the number of ant species collected by Japanese scientists in 1982 (for the tentative list of ants collected by T. Abe & Sk. Yamane in 1982, see also Yamane 2005). More recently Taylor (1992) has described a new ant species from Anak Krakatau.

Previous collections of ants on the Krakataus have been done by searching at ground level (under stones, in soil and rotting wood, etc.), beating, sweep-netting and extracting from leaf-litter (Thornton & Rosengren 1988). Intensive ant collection by sweep-netting is still needed to know the ant activity on lower vegetation. Ito *et al*. (2001) mentioned that ant species composition was remarkably different among sampling methods, especially between ants on trees and those on ground. Several rare species sampled from litter and surface soil may be common on trees. We therefore undertook a survey by intensive sweep-netting to better understand the ant species composition on lower vegetation

MATERIALS AND METHODS

Ants were collected by intensive sweep-netting on shrubs, grasses, and lower branches of trees, to a height of about 3 m, on Rakata, Sertung, Panjang, Anak Krakatau, Sebesi, and Sebuku by second author (RU) during 11-20 August 2005. The Krakatau group (Figure 1) is located about 44 km from Java and Sumatera and consists of four small closely-situated islands, among which the largest is Rakata (11.5 km^2) at 06°08'S, 105°25'E followed by Sertung (7.9 km^2) at 06°04'S, 105°24'E, Panjang (2.7 km^2) at 06°04'S, 105°24'43"E, and Anak Krakatau (2 km^2) at 06°06"S, 105°26'E. Anak Krakatau is an active volcano, and surrounded by the other three islands. Sebesi is situated at only 15 km from Sertung with an area of approximately 37 km^2. It was also damaged by the 1883 eruptions, but not to the same extent as the Krakataus (Dammerman 1948, Thornton &

Rosengren 1988). Sebuku lies between Sebesi and Sumatra, and was severely affected by the 1883 tsunami. These both islands have since been cultivated and no natural forest remains.

The quantitative ant sampling was carried out by intensive sweep-netting for one hour randomly in three replicates on each island, except in Sebuku which were taken only one unit sample as that time was raining in that island. Grasses, shrubs, understory and lower branches of trees were mainly swept with an insect net, 60 cm in diameter and installed to an adjustable stick of 250 cm. Ants were collected from the net using an aspirator and then preserved in 80% alcohol. Point/pin-mounting, sorting and tentative identification of the specimens were done at Bogor Zoological Museum, and some were identified to species at Kagoshima University, Japan. Bolton (1994) was used for identification of the ants to genus. The species level identification was made using more specialized taxonomic papers for some well-studied groups. Specimens are deposited in the entomological collection at Bogor Zoological Museum (MZB.HYMN.17611-17970).

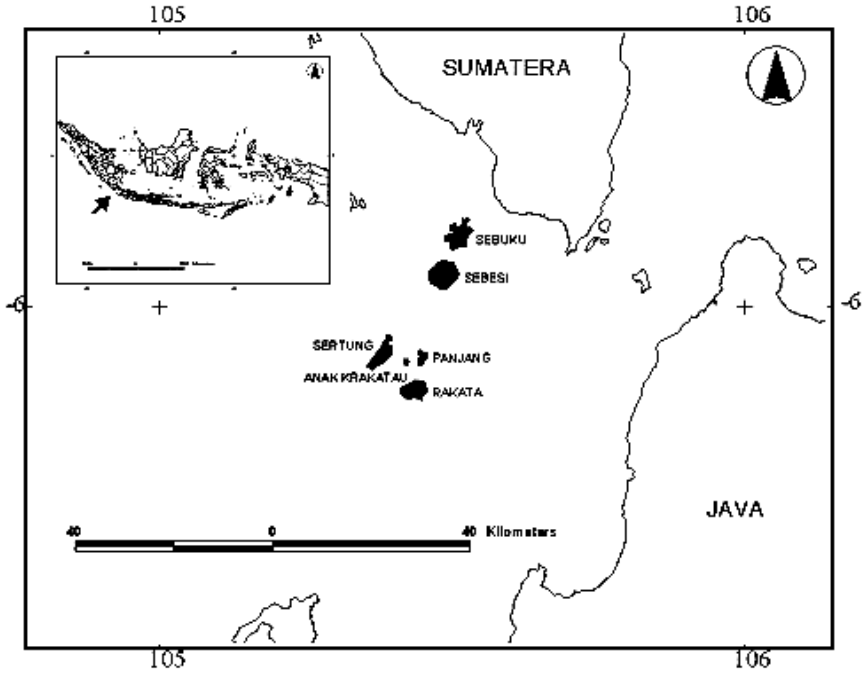

Figure1. Map of Sunda straits, with study sites (black)

RESULTS

A total of 46 species of ant in 20 genera and 5 subfamilies were collected during the survey (Tables 1 and 3). Similar numbers of species and genera were found from the six islands except on Sebuku.

The ant fauna of the Krakataus

Among the samples from the Krakataus, 37 species belonging to 17 genera are recognized (Table 1). The numbers of species/genera are: Rakata 15/12, Sertung 13/10,

Table 1. Ants collected on the Krakataus

Species	Islands	Species	Islands
Subfamily Dolichoderinae (6)		**Subfamily Myrmicinae (20)**	
Iridomyrmex anceps (Roger)	4	*Cardiocondyla tjibodana* Karavaiev	4
Ochetellus sp. 1	4	*Cardiocondyla* sp. 2	4
Philidris sp. 1	1, 2, 3	*Crematogaster difformis* Smith F.	1, 2, 3, 4
Tapinoma sp. 1	4	*Crematogaster* sp. 2	1, 4
Technomyrmex albipes (Smith F.)	2	*Crematogaster* sp. 3	3, 4
Technomyrmex horni Forel	2, 3	*Crematogaster* sp. 4	1, 4
		Monomorium destructor (Jerdon)	1, 4
Subfamily Formicinae (10)		*Monomorium floricola* (Jerdon)	3, 4
Anoplolepis gracilipes (Smith)	1, 2, 3, 4	*Monomorium pharaonis* (Linnaeus)	2
Camponotus arrogans (Smith F.)	2, 3	*Monomorium sechellense* Emery	4
Camponotus sp. 2	2	*Monomorium* sp. 5	1
Camponotus sp. 3	1	*Pheidole fervens* (Smith F.)	1
Oecophylla smaragdina (Fabricius)	1, 2, 3, 4	*Pheidole plagiaria* (Smith F.)	2
Paratrechina longicornis (Latreille)	4	*Pheidole sauberi* Forel	3, 4
Paratrechina sp. 2	3, 4	*Pheidole* sp. 4 (cf. *oceanica*)	4
Paratrechina sp. 3	1, 2	*Strumigenys godeffroyi* Mayr	1
Polyrhachis arcuata (Le Guillou)	4	*Tetramorium bicarinatum* (Nylander)	3, 4
Polyrhachis caligata Emery	1	*Tetramorium lanuginosum* Mayr	2
		Tetramorium pacificum Mayr	2, 3
Subfamily Ponerinae (1)		*Tetramorium* sp. 4 (aff. *tonganum*)	1
Odontoponera denticulata (Smith F.)	1		

[1]Rakata, [2]Sertung, [3]Panjang, and [4]Anak Krakatau

Panjang 12/10, and Anak Krakatau 20/12. The most frequently recorded species were *Anoplolepis gracilipes* (12 replicates, 4 islands), *Oecophylla smaragdin*a (12, 4), and *Crematogaster difformis* (12, 4), and *Philidri*s sp. 1 (9, 3). Three tramp species, *Monomorium destructor, M. pharaonis, and Paratrechina longicornis*, are recorded. *Monomorium destructor* was sampled from Rakata and Anak Krakatau, *M. pharaonis* only from Sertung, and *Paratrechina longicornis* only from Anak Krakatau.

In this study, a total of 320 ants were collected from the Krakataus (Table 2). Comparison of the communities on different islands at the subfamily level shows that ants on lower vegetation were most abundant on Anak Krakatau, followed by Rakata, Panjang and Sertung. As a whole myrmicine ants were most abundant, followed by formicines and dolichoderines, whereas on Sertung, formicines were most abundant, followed by dolichoderines and myrmicines.

Table 2. Abundance of ants on the Krakataus

Subfamily	Abundance (number of individuals)			
	Rakata	**Sertung**	**Panjang**	**Anak Krakatau**
Dolichoderinae	1	16	9	10
Formicinae	17	21	13	12
Myrmicinae	57	13	33	117
Ponerinae	1	-	-	-
Total	**76**	**50**	**55**	**139**

The ant fauna of Sebesi and Sebuku islands

Fifteen species belonging to 13 genera in 4 subfamilies were collected from Sebesi. On Sebuku, 4 species belonging to 3 genera in 2 subfamilies were collected (Table 3). Only three species, *Anoplolepis gracilipes*, *Crematogaster* sp. 2, and *Paratrechina* sp. 3, were collected on both the islands. One tramp species, *Monomorium floricola*, was sampled on Sebesi.

Table 3. Ants collected on Sebesi and Sebuku islands

Species	Islands	Species	Islands
Subfamily Dolichoderinae (2)		**Subfamily Formicinae (8)**	
Dolichoderus thoracicus (Smith)	5	*Anoplolepis gracilipes* (Smith)	5, 6
Tapinoma sp. 2 (aff. *indicum*)	5	*Camponotus camelinus* (Smith)	5
		Camponotus sp. 5	5
Subfamily Ectatomminae (1)		*Oecophylla smaragdina* (Fabricius)	5
Gnamptogenys bicolor (Emery)	5	*Paratrechina longicornis* (Latreille)	5
		Paratrechina sp. 3	5, 6
Subfamily Myrmicinae (5)		*Paratrechina* sp. 4	6
Cardiocondyla sp. 3 (cf. *tsukiyomi*)	5	*Polyrhachis rufipes* (Smith F.)	5
Crematogaster sp. 2	5, 6		
Monomorium floricola (Jerdon)	5		
Recurvidris kemneri (Wheeler & Wheeler)	5		
Tetramorium pacificum Mayr	5		

[5] Sebesi, and [6] Sebuku

In total, 48 individuals were collected from Sebesi (39) and Sebuku (9) (Table 4). On Sebesi, the most abundant subfamily was Myrmicinae, followed by Formicinae, Dolichoderinae etc. whereas on Sebuku, we only collected Formicinae and Myrmicinae.

Table 4. Abundance of ants on Sebesi and Sebuku islands

Subfamily	Abundance (number of individuals)	
	Sebesi	Sebuku
Dolichoderinae	5	-
Ectatomminae	1	-
Fomicinae	11	5
Myrmicinae	22	4
Total	**39**	**9**

DISCUSSION

After Dammerman's synthetic publication (1948), no intensive ant faunal survey was carried out on the Krakataus until 1980s. Thornton & New (1988) recorded 68 ant species, based on the results by T. Abe & Sk. Yamane in 1982, without a species list, and Taylor (1992) described a new species of the genus *Rhoptromyrmex* from Anak

Krakatau. Yamane (2005) listed 77 species also based on the unpublished data collected by Abe & Yamane in 1982. Recent ant survey on the Krakataus by Yamane in 2006/2007 recognized 95 species (Yamane's personal data, unpublished).

Among the islands of the Krakatau group, the present results using net-sweeping showed Anak Krakatau had the highest number of ant species (20 species), followed by 15 for Rakata, 13 for Sertung, and 12 for Panjang. The high number for Anak Krakatau could be partly explained by the coastal vegetation dominated by shrubs and sparse forests including pioneer trees with extra floral nectarines which are frequently used by ants. The island is visited more often than other islands, which may have facilitated the introduction of tramp/anthropogenic ant species. The introduced ants from Sumatra or Java to Anak Krakatau are *Iridomyrmex anceps*, *Paratrechina longicornis*, *Cardiocondyla tjibodana*, *Monomorium sechellense*, *Anoplolepis gracilipes*, *Monomorium destructor*, *M. floricola*, *Tetramorium bicarinatum*, and the first 4 species were found only on Anak Krakatau during this survey (see Table 1).

Among the 37 species recorded here *Monomorium destructor, M. sechellense* and *Ochetellus* sp. 1 were recorded from the Krakataus for the first time. Some *Pheidole* species such as *P. fervens* and *P. sauberi*, and two *Cardiocondyla* species may have been collected by Abe and Yamane in 1982 but confirmation to the specimens could not be done (see Yamane 2005). *Phildris* sp. 1 is most probably "*Iridomymrmex cordatus*" in Wheeler (1937) and Dammerman (1948). *Camponotus arrogans* is one of the most common species of the subgenus *Tanaemyrmex* in the Sunda region, and may be the same as "*Camponotus irritans*" in Wheeler (1937) and Dammerman (1948). Based on Bogor Zoological Museum collection and Sk. Yamane collection, most of these species are also known to spread over Java and Sumatra. *Pheidole plagiaria* was collected on Sebesi during 1919-21 but was not found on the Krakataus in that period (Wheeler 1924). This suggests that the Krakatau population of *P. plagiaria* may have originated from Sebesi, though this species is also common on Java.

Species richness was highest for subfamily Myrmicinae (20 spp.), Formicinae (10), Dolichoderinae (6), with fewer species of Ponerinae (1). The most species-rich genus was *Monomorium* (5 spp.), followed by *Crematogaster* (4), *Pheidole* (4), *Tetramorium* (4), *Camponotus* (3), and *Paratrechina* (3). The ant genera such as *Camponotus*, *Crematogaster*, and others have many arboreal species (Widodo *et al.* 2004), but nests of some of them can be found on ground surface, in rotting wood and soil.

The two formicine species *Anoplolepis gracilipes* and *Oecophylla smaragdina* are commonly found on trees and shrubs on the Krakataus. However they never coexisted in the same microhabitats or they were never found on the same tree. *O. smaragdina* was found mainly along the coast but *A. gracilipes* was also found deep in the forest.

Fifteen ant species were collected from Sebesi, the number being equal to that from Rakata, and only 4 species from Sebuku. Among them *Anoplolepis gracilipes, Oecophylla smaragdina, Paratrechina longicornis, Paratrechina* sp. 3, *Crematogaster* sp. 2, *Monomorium floricola,* and *Tetramorium pacificum* were also collected from the Krakataus. But some were only collected from Sebesi/Sebuku, *e.g. Camponotus camelinus, Gnamptogenys bicolor*, *Polyrhachis rufipes,* and *Recurvidris kemneri*. The difference between the Krakataus and Sebesi/Sebuku may be explained by different vegetations (Dammerman 1948) and preservation of an older fauna on the latter after the 1883 eruptions. The extremely low number of species collected on Sebuku is in part due to the very limited time spent for survey.

We are unable to make a meaningful comparison between our survey and previous surveys because of the difference in survey method. Although the present results may help understand how much percentage of the whole ant fauna is found on lower vegetation, we should know the behavior of ants on trees and shrubs, including the interaction of ants with other animals and plants.

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