Ant fauna of Tanega-shima Island, the northern Ryūkyūs (Hymenoptera, Formicidae)

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Recent zoogeographic studies have centered on the species-area relation, species turnover and equilibrium, faunal similarity between neighbouring regions (islands) expressed quantitatively, etc. (MacArthur & Wilson, 1967; Kimoto, 1982). In this respect Tanega-shima is an interesting island for two reasons. First, it is situated close to Yaku-shima which has a similar area (447.42 km^2 vs 500.59 km^2), but is dominated by mountains (the highest peak is 1935 m alt.), while Tanega-shima is a typical low-island (Mezaki, 1980). Thus, a thorough investigation of the fauna of these islands may help answer the question of whether habitat diversity rather than area itself definitely affects the animal species number or not. Second, Tanega-shima may represent a transitional faunal zone between warm-temperate and subtropical regions.

The insect fauna of this island, however, has so far received little attention. In 1982 we collected ants at two localities on this island, including seashores, hill slopes, and the highest point (282 m alt.) on the island. The results were compared with those for neighbouring islands and mainland Japan (Kagoshima-ken-hondo). In this short paper we describe and discuss the ant fauna of Tanega-shima, and habitat preference in some species.

Before going further we thank Mr. Kiyonori Tomiyama (Kagoshima Univ.) for his help in collecting ants, and Mr. Mamoru Terayama (Tokyo Univ.) for his help both in identifying ant species and for various suggestions.

Survey areas

Collections were made at Makikawa (30° 37′ 15″N, 130° 58′ 20″E) on the west coast of Nakatane-chô on 3-5 May, 1984, and at Hamada (30° 26′ 30″N, 130° 58′ 30″E) on the east coast of Minamitane-chô on 31 July-2 August, 1984 (Fig. 1). In Makikawa, the survey was carried out along a road for about 3.5 km from the seashore to the highest point on the island (282 m alt.) and included open lands and forests. In Hamada, the seashore and its associated vegetation was chiefly surveyed. In both areas ants were collected by close inspections of ground surface, by digging soil, and by

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dissecting fallen tree trunks and branches. Tullgren apparatus was not used so that some small species might have been missed.

Results and Discussions

1. Species number and composition

A total of 33 ant species were collected during the two survey periods on Tanega-shima (Table 1). This figure corresponds to approximately half the number of

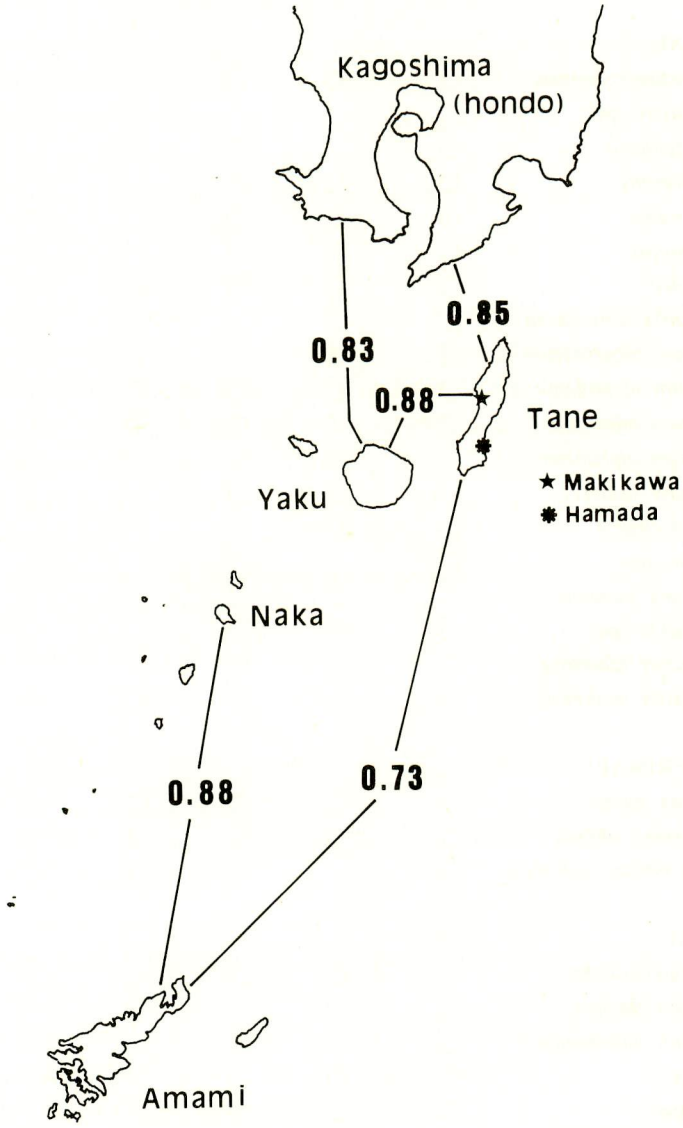

Fig. 1. Map of the region discussed, with Nomura-Simpson's Coefficients between the "islands".

Table 1. Ant species collected from Tanega-shima, and their distribution in its neighbourings.

Species	Tanega-shima		Yaku-shima	Nakano-shima	Amami-ōshima	Kagoshima-ken-hondo
	Makikawa	Hamada				
PONERINAE						
1. *Brachyponera chinensis*	○	○	○	○	○	○
2. *Tachymesopus pilosior*		○	○	○		
3. *Hypoponera* spec.		○	○	○	○	○
4. *Odontomachus monticola*	○	○	○			○
MYRMICINAE						
5. *Aphaenogaster osimensis*	○	○	○		○	○
6. *Aphaenogaster* spec.	○				○	
7. *Messor aciculatus*	○		○			○
8. *Pheidole fervens*	○	○	○		○	○
9. *Pheidole indica*	○	○	○	○	○	○
10. *Pheidole nodus*	○	○	○		○	○
11. *Pheidole pieli*	○	○	○	○	○	○
12. *Triglyphothrix lanuginosa*		○			○	○
13. *Tetramorium bicarinatum*	○	○	○	○	○	○
14. *Tetramorium nipponense*	○	○	○	○	○	
15. *Monomorium minutum*	○	○	○	○	○	○
16. *Monomorium nipponense*		○	○	○	○	○
17. *Oligomyrmex sauteri*		○	○		○	○
18. *Vollenhovia emeryi*	○	○	○			○
19. *Vollenhovia* spec.	○		○			
20. *Pristomyrmex pungens*	○	○	○		○	○
21. *Cardiocondyla* spec.	○	○	○		○	○
22. *Crematogaster laboriosa*	○	○	○		○	○
23. *Crematogaster osakensis*	○	○	○	○	○	○
DOLICHODERINAE						
24. *Iridomyrmex glaber*	○	○	○	○	○	○
25. *Technomyrmex albipes*	○	○	○	○	○	○
26. *Tapinoma melanocephalum*	○		○	○	○	○
FORMICINAE						
27. *Paratrechina sakurae*	○	○	○		○	○
28. *Paratrechina flavipes*	○	○	○			○
29. *Paratrechina bourbonica*	○	○			○	○
30. *Lasius niger*	○	○	○			○
31. *Formica* spec.	○	○	○			○
32. *Camponotus tokioensis*	○	○				○
33. *Camponotus nipponicus*		○	○	○	○	○

species known from Yaku-shima (63 species : Terayama & Yamane, 1984 ; Terayama, personal communication). Since these two islands have similar areas (Table 2), other factors may be responsible for the notable difference in species number between them.

First, Yaku-shima has been more intensively surveyed than Tanega-shima. Okadome (1973) listed 13 species chiefly based on the materials gathered by himself and K. Yamagishi in 1970-71. Terayama made an intensive collection in 1981 along a climbing road from seashore to mountain top (1850 m alt.), and a supplementary survey in 1984 recorded a total of 47 species. Yamane also made two intensive collections at various altitudes and confirmed 39 species (Terayama & Yamane, 1984). On the other hand, Tanega-shima has been surveyed only twice (present study). Thus, the difference in collection effort may be partly responsible for the smaller species number for Tanega-shima.

A second possible factor is the more diverse habitat on Yaku-shima ; "natural" forests are relatively preserved, and high mountains dominate. Comparing the species compositions on Tanega-shima and Yaku-shima, it is obvious that most of the species collected on the former also inhabit Yaku-shima, while all the species collected above 500 m alt. alone on Yaku-shima were lacking on Tanega-shima (for a similar situation in cerambycid fauna, see Mori, 1984). This fact cannot be explained by the less intensive surveys on Tanega-shima, and indicates a strong relationship between the high elevation and its associated vegetation and the variety of ant fauna of Yaku-shima. Though other species will undoubtedly be found in the future on Tanega-shima, we can safely conclude that, in the present case, habitat diversity is an important factor determining species number.

To express faunal relations between Tanega-shima and its adjacent islands, Nomura-Simpson's Coefficients (*NSC*) were calculated. *NSC* is given in the following equation (Kimoto, 1982) :

$$NSC = c/n_1 \qquad n_1 < n_2$$

(n_1 and n_2 are total numbers of species found in the areas 1 and 2, respectively, and c is the number of species found in both areas.)

Table 3 shows *NSC*s between several areas near Tanega-shima, calculated mainly based upon the lists for Kagoshima-ken-hondo (Terayama, 1983 ; personal communication), Yaku-shima (Terayama & Yamane, 1984), Tanega-shima (present study ; Table 1), and Nakano-shima and Amami-ôshima (Abe, 1977 ; Terayama, personal communication). Tanega-shima has the closest faunal relation with Yaku-shima and Kagoshima-ken -hondo. This means that these three areas have many lowland species in common, and that Tanega-shima is inhabited by lowland species alone. Thus, though *NSC* between Tanega-shima and Yaku-shima is notably large (0.88), there are about 20 mountain (temperate-zone) species that are found only on Yaku-shima. Ant fauna of Nakano-shima, a small island belonging to the Tokara group, mainly consists of subtropical elements ; *NSC* between this island and Tanega-shima is quite small (0.

Table 2. Area and ant species number in the region discussed

Island name	area	species number
Kagoshima-ken-hondo	ca.6700 km^2	78
Amami-ōshima	718.74	71
Yaku-shima	500.59	63
Tanega-shima	447.42	33
Nakano-shima	27.50	26

Table 3. Nomura-Simpson's Coefficients between the five "islands".

Amami-ōshima				
0.88	Nakano-shima			
0.43	0.58	Yaku-shima		
0.73	0.54	0.88	Tanega-shima	
0.46	0.62	0.83	0.85	Kagoshima-ken-hondo

54). It is very impressive to compare *NSC* between Tanega-shima and Amami-ôshima with that between Yaku-shima and Amami-ôshima (0.73 vs. 0.43). This difference may be due to (1) high proportion of mountain species on Yaku-shima, and (2) almost complete lack of them on Tanega-shima. In conclusion the ant fauna of Tanega-shima may well be understood as a mixture of temperate and subtropical lowland species.

2. Habitat preference

Ants were collected at 13 sites in Makikawa, and 7 in Hamada. These sites were classified into the following: (A) seashore, (B) devastated ground (often with sparse herbs), (C) *Cryptomeria* plantation, (D) secondary forest (broad-leaved and evergreen), and (E) forest along stream, in Makikawa ; and (a) seashore, (b) devastated ground, (c) shrubbery, (d) *Pinus* forest near coast, and (e) secondary forest (broad-leaved and evergreen) in Hamada. Though the number of collection sites and collection effort varied slightly among habitat types, it is obvious from Table 4 that ant fauna was poorest in *Cryptomeria* and *Pinus* forests (plantations), and that other habitat types harboured similar numbers of ant species.

Some species were found to be restricted mainly to open sites, while others to broad-leaved forests (Fig. 2). For example, Ponerinae were largely collected from dark and wet forest floors ; most individuals of *Brachyponera chinensis* were found from the litter layer of secondary forests. In Dolichoderinae, *Technomyrmex albipes* was

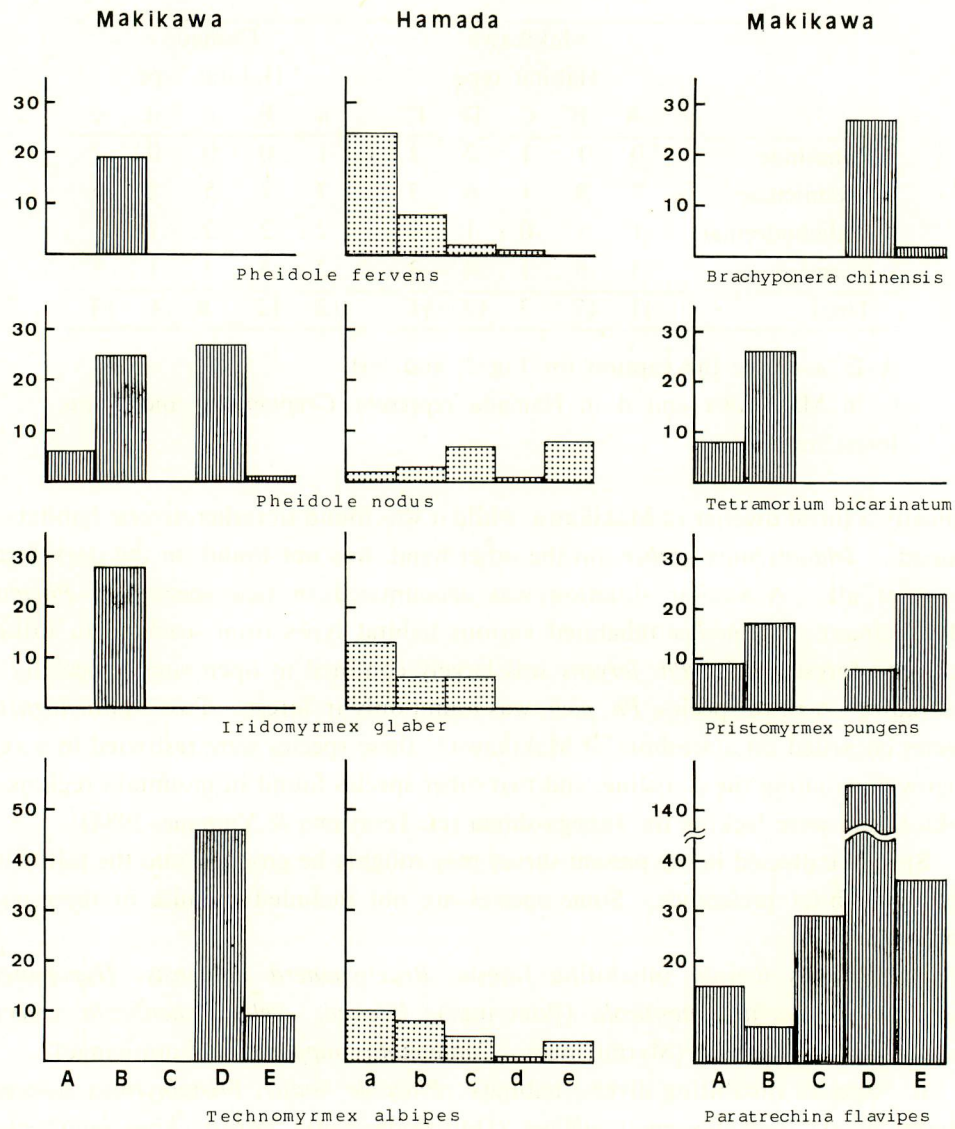

Fig. 2. Habitat preference in some ant species on Tanega-shima. (In the 4 species at the right, data are presented for Makikawa alone.) A : seashore, B : devastated ground, C : *Cryptomeria* plantation, D : secondary forest, E : forest along stream. a : seashore, b : devastated ground, c : shruberry, d : *Pinus* forest, e : secondary forest. (See also text.)

Table 4. Numbers of ant species collected in different habitat types

	Makikawa Habitat type					Hamada Habitat type				
	A	B	C	D	E	a	b	c	d	e
Ponerinae	0	1	1	2	2	1	0	0	0	2
Myrmicinae	7	9	1	6	5	7	7	5	2	6
Dolichoderinae	1	1	0	1	1	2	2	2	1	1
Formicinae	3	6	1	4	3	2	3	2	1	5
Total	11	17	3	13	11	12	12	9	4	14

A–E, a–e: see the caption for Fig. 2, and text.
C in Makikawa and d in Hamada represent *Cryptomeria* and *Pinus* forest, respectively.

typically a forest dweller in Makikawa, while it was found in rather diverse habitats in Hamada. *Iridomyrmex glaber*, on the other hand, was not found on the dark forest floors at all. A similar situation was encountered in two species of *Pheidole* (Myrmicinae): *Ph. nodus* inhabited various habitat types from seashore to hilltop including forests, while *Ph. fervens* was largely confined to open sites, especially in Makikawa. A third species, *Ph. pieli*, was found only in forests. Two *Aphaenogaster* species coexisted on a seashore of Makikawa; these species were restricted to a very narrow zone along the coastline, and two other species found in mountain regions of Yaku-shima were lacking on Tanega-shima (cf. Terayama & Yamane, 1984).

Species collected in the present survey may roughly be grouped into the following types in babitat preference. Some species are not included because of their poor representation.

A. Species mainly inhabiting forests: *Brachyponera chinensis*, *Hypoponera* spec., *Odontomachus monticola* (Ponerinae); *Pheidole pieli*, *Vollenhovia emeryi*, *Crematogaster laboriosa* (Myrmicinae); *Camponotus nipponicus* (Formicinae).

B. Species inhabiting diverse habitats: *Pheidole nodus*, *Pristomyrmex pungens* (Myrmicinae); *Technomyrmex albipes* (Dolichoderinae); *Paratrechina bourbonica*, *P. flavipes*, *Formica* spec., *Camponotus tokioensis* (Formicinae).

C. Species inhabiting open sites: *Pheidole fervens*, *Tetramorium bicarinatum*, *Monomorium minutum*, *Cardiocondyla* spec. (Myrmicinae); *Iridomyrmex glaber* (Dolichoderinae).

D. Species inhabiting seashores: *Aphaenogaster osimensis*, *A.* spec. (Myrmicinae); *Tapinoma melanocephalum* (Dolichoderinae).

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