Comparative Studies of Various Symbiotic Relationships Between Rubiacerous Epiphytic Myrmecophytes and Their Inhabitant Ant Species (Hymenoptera: Formicidae)

by

T. Maeyama[1], M. Terayama[1] & T. Matsumoto[1]

ABSTRACT

Quantitative surveys and comparative studies were carried out on various species of rubiacerous epiphytic myrmecophytes in the Australian and the Oriental regions. Forty ant species in 18 genera arose in the myrmecophytes of 14 species in 3 genera. The dominant ants species are *Philidris* and *Dolichoderus* in almost all cases. The species number of inhabitant ants and ant occupancy rates of each myrmecophyte fluctuated greatly. The relationships between ants and epiphytic myrmecophytes extended from specific obligate symbioses to loose arbitrary ones. Their symbiotic relationships were extreme diverse.

Key words: myrmecophyte, Hydnophytinae, inhabitant ant, symbioses.

INTRODUCTION

Many myrmecophytes have interesting symbiotic relationships with their associated ant species in tropical and subtropical regions (Jolivet, 1996). However, there have been few reports of comparative and quantitative studies of the inhabiting ant fauna in the diverse symbioses between myrmecophytes and ants. In addition, the fundamental investigations have not been carried out yet in the symbiotic relationships between the epiphytic myrmecophytes in Hydnophytinae (Rubiaceae) and their occupant ants. Although Huxley (1978) reported some ant species from some these myrmecophytes, the data was not quantitative because of small sample size. In the other studies, a few ant fauna were reported in the plants of Hydnophytinae (Janzen, 1974; Huxley, 1982; Kiew & Anthonysamy, 1987), but they were not enough for the comparative study. Then, we surveyed the ant composition detected from 14 species in 3 genera of Hydnophytinae in Papua New Guinea, Malaysia and Australia, and analyzed them by quantitative and comparative methods.

[1]Department of Biology, College of Arts & Sciences, The University of Tokyo, 3-8-1, Komaba, Meguro, Tokyo 153, Japan

Table 1. Ant species inhabiting in their host myrmecophytes in each study area.

Code	Study Area (Province)	Habitat	Myrmecophyte Species	Ant Species	Sample Number	Occupancy Rate (%)
	PAPUA NEW GUINEA					
1	Bundi (Madang)	MF	*M. gracilispina*	*Dolichoderus* sp. A	55	100.0
1	Bundi (Madang)	MF	*M. horrida*	*Dolichoderus* sp. B	26	100.0
2	Goroka (Eastern Highlands)	MF, SD		*Dolichoderus* sp. C	21	100.0
1	Bundi (Madang)	MF	*M. melanacantha*	*Dolichoderus* sp. B	38	100.0
2	Goroka (Eastern Highlands)	MF, SD		*Dolichoderus* sp. C	27	100.0
3	Balirata (Central)	SD, SO	*M. platytyrea*	*Philidris* sp. A	19	82.6
				Dolichoderus sp. D	4	17.4
4	Wau (Morobe)	SD, SO		*Iridomyrmex* sp. A	13	81.3
				Anoplolepis gracilipes	3	18.8
2	Goroka (Eastern Highlands)	MF, SD	*M. pteroaspida*	*Dolichoderus* sp. C	35	100.0
1	Bundi (Madang)	SD	*M. schlechteri*	*Philidris* sp. B	41	69.5
				Philidris sp. C	9	15.3
				Pheidole sp. A	7	11.9
				Anoplolepis gracilipes	2	3.4
2	Goroka (Eastern Highlands)	SD		*Philidris* sp. D	86	100.0
5	Simbai (Madang)	SD, SO		*Iridomyrmex* sp. B	52	76.5
				Crematogaster sp. A	16	27.6
4	Wau (Morobe)	SD, SO	*M. tuberosa*	*Dolichoderus* sp. E	37	74.0
				Camponotus sp. A	8	16.0
				Dolichoderus sp. F	5	10.0
4	Wau (Morobe)	MF	*M.* sp.	*Dolichoderus* sp. E	16	100.0
6	Madang (Madang)	MG	*H. moseleyanum*	*Philidris* sp. E	113	34.2
				Camponotus sp. B	34	10.3
				Crematogaster sp. B	14	4.2
				Tapinoma sp.	10	3.0
				Opithopsis maurus	7	2.1
				Monomorium sp.	7	2.1
				Philidris sp. F	6	1.8

Table 1. Ant species inhabiting in their host myrmecophytes in each study area (continued).

				Opithosis sp.	5	1.5
				Colobopsis sp. A	3	0.9
				Tetraponera sp.	3	0.9
				Paratrechina sp.	1	0.3
				No ant	127	38.5 *
4	Wau (Morobe)	MF	*H. myrtifolium*	No ant	32	100.0 *
4	Wau (Morobe)	MF	*A. caerulea*	*Dolichoderus* sp. E	241	99.6
				Dolichoderus sp. G	1	0.4
7	Patep (Morobe)	SD, SO	*A. echinella*	*Dolichoderus* sp. H	8	8.9
				Polyrhachis sp.	6	6.7
				Philidris sp. G	6	6.7
				Camponotus sp. C	5	5.6
				Colobopsis sp. B	4	4.4
				Brachyponera sp.	4	4.4
				Pheidole sp. B	3	3.3
				Platythyrea parallela	3	3.3
				Technomyrmex sp.	3	3.3
				Philidris sp. H	1	1.1
				No ant	47	52.2 *
	MALAYSIA					
8	Bako (Sarawak)	SD, SO	*M. tuberosa*	*Philidris* sp. I	40	100.0
8	Bako (Sarawak)	SD, SO	*H. formicarium*	*Philidris* sp. I	179	97.3
				Cataulacus sp.	1	0.5
				No ant	4	2.2 *
	AUSTRALIA					
9	Cape Triburation (Queensland)	MG	*M. beccary*	*Philidris* sp. J	17	100.0

Habitat: MF, Mountain Forest; SD, Secondary Forest and Disturbed Area; SO, Savanna and Open-canopied Environment; MG, Mangrove Forest. Myrmecophyte Species: M., *Myrmecodia*; H., *Hydnophytum*; A., *Anthorrhiza*. Sample Number: Individual number of the myrmecophytes of which each ant species appeared on the surface. Occupancy Rate: Percentage of myrmecophyte individual number occupied by each ant species in each study area. *Unoccupancy Rate: Percentage of myrmecophyte individual number unoccupied by any ant species.

MATERIALS AND METHODS

The Hydnophytinae in Rubiaceae contains 88 species in 5 genera, and almost all species are epiphytic myrmecophytes (Huxley, 1991; Jebb, 1993). They are distributed from southeastern Asia to Oceania, and show the highest species number on New Guinea Island. The lower part of their stem forms one swollen tuber that has complicated cavities inside. Ants often inhabit these cavities. There are two kinds of cavity surfaces in most species in Hydnophytinae: One is smooth and the other is rough and warted. The experiments using radioactive isotopes showed that *Myrmecodia tuberosa* can absorb the nutrients through warted cavity surface from the debris stored by inhabitant ants (Huxley, 1978). The same result was obtained also on *Hydnophytum formicarium* (Rickson, 1979). The investigations were carried out in the habitats of the myrmecophytes in Papua New Guinea, Malaysia and Australia from March 1992 to November 1995. The ants occupying the myrmecophytes appeared on the tuber surface when the plant tubers were disturbed by tapping or knocking. After all the plants whose tubers were more than 5 cm in diameter were knocked, the ants which appeared were caught and identified.

RESULTS AND DISCUSSION

Forty ant species in 18 genera were detected from the myrmecophytes of 14 species in 3 genera (Table 1). These results showed that extreme diverse ant fauna utilized the epiphytic myrmecophytes as the living space. Although some myrmecophyte species appeared in mountain forests, most species were usually abundant in open-canopied environments or damaged areas. This tendency supports previous studies reported in Janzen (1974), Huxley (1978, 1980, 1982), Beattie (1985), Jebb (1985), Keeler (1989). These studies showed some ant species as the inhabitants in Hydnophytinae, in which the dominant ants were usually *Iridomyrmex cordatus* or *I. scrutator*. In our results, the most dominant species belonged to the genera *Philidris* or *Dolichoderus* in almost all the cases. The species of *Philidris* corresponds to *Iridomyrmex cordatus* reported so far, and there is a possibility that *Dolichoderus* ants are conspecific with *Iridomyrmex scrutator* (Maeyama, 1995). All the ant species except *Anoplolepis grasilipes*, *Opithopsis maurus*, and *Platythyrea parallela* could not be identified to species level, because of the extreme confusion of the classification of New Guinean ants. Both occupancy rate and ant species number inhabiting each myrmecophyte species varied greatly. The occupancy rate of ants fluctuated from 0% (*H. myrtifolium*) to 100% (*M. gracilispina, M. pteroaspida, M. beccary*). The species number of ants appeared in their host plants changed from 1 (*M.*

gracilispina, M. beccary) to 11 (*H. moseleyanum*). The relationships between ants and epiphytic myrmecophytes extends from the specific obligate symbioses to the loose facultative ones. These results suggest that much more diverse symbiotic relationships exist in ant-plant interactions than that reported in previous studies. Two species of myrmecophytes are distributed sympatrically, sometimes even occurring on the same host tree, i. e., *M. horrida* and *M. melanacantha* in Bundi, *M. tuberosa* and *H. formicarium* in Bako, *M. tuberosa* and *M. platytyrea, A. caerulea,* and *M.* sp. in Wau. One ant colony utilized all individuals of 2 myrmecophytic species on the same tree in all cases. In Goroka, 3 species of *M. pteroaspida, M. horrida,* and *M. melanacantha* rarely existed on one tree, and one colony of *Dolichoderus* sp. C occupied all of the plants. Interestingly, *M. schlechteri* also distributed sympatricly with the other 3 species of *Myrmecodia*, but did not occur together at all. *Myrmecodia schlechteri* always appeared in a single species on a host tree, and inhabited by *Philidris* sp. D. This species and the other 3 seemed to make habitat segregation in sympatric region, probably by the influence of the occupancy of different ant species. Our results revealed that numerous ant species have various symbiotic relationships with many of the epiphytic myrmecophyte species. Their relationships are diverse indeed. More detailed ecological studies should be carried out in the future about their symbioses and their interactions.

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