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# Some Ecological Observations on Social Wasps (Insecta: Hymenoptera: Vespidae) in the Northern Mariana Islands, Micronesia

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**Abstract** Twenty-six nests of three social wasp species were collected with nearly all their adult members and all immatures in the northern Mariana Islands. *Ropalidia marginata sundaica* and *Polistes stigma* were inferred to have an asynchronous life cycle, whereas *Polistes olivaceus* was to have a synchronous life cycle. Solitary colony founding was ascertained in all three species. Each colony of *R. marginata sundaica* had only one female with a well developed ovary, which was presumably an egg-layer, except for two large colonies, although about half of the females in each colony were inseminated. Females with developed ovaries were significantly larger than those with undeveloped ovaries, but there was no significant size difference between inseminated and uninseminated females which had undeveloped ovaries. In *P. olivaceus*, there was a marked difference in body proportion between founding queens and first daughters, but this difference can be explained by allometric growth, and is not considered to be a morphologically discrete caste difference.

**Key words:** northern Mariana Islands, *Polistes olivaceus*, *P. stigma*, *Ropalidia marginata sundaica*, social wasp, solitary colony founding, synchronous and asynchronous life cycles.

Long-term field studies are usually needed to clarify the ecological and sociobiological features of social insect species. However, it is possible to infer details of their social life from specimens collected even in a short time, if entire colonies including almost all adult and immature members are obtained. Although the duration of our survey on the northern Marianas was very short, about 30 days, I collected 26 colonies of three species of social wasps during the expedition. In this paper, I provide some ecological information and other data obtained from these colonies and outline the social life of these wasps in the northern Marianas.

## Materials and Methods

Nine of the northern Mariana Islands were visited (Fig. 1), and an extensive search was made for colonies of social wasps. When a colony was found, the substratum and height of the position of the nest above the ground were recorded. Then, the nest with immatures and adults was collected, and adults which returned to the nest were usually caught with a net for at least an hour. Each nest with immatures, its attending adults, and its returning adults, was preserved separately in 75% alcohol. After returning to Japan, the nest content was examined, and the number of adults was counted. Females were dissected under a binocular microscope to examine the condition of their spermatheca and the degree of ovarian development. Head width (HW), thoracic width (TW), and wing length (WL) of females were measured using an optic micrometer to the nearest 0.05 mm. WL is not the true length of the wing, but the distance from the proximal end of the 1st discoidal cell to the distal margin of the marginal cell of the right forewing (Fig. 2).

Besides colony collection, wasps flying over the vegetation were also caught with a net.

## Results

### 1. *Ropalidia marginata sundaica*

This species was caught on eight of the nine islands surveyed (See Miyano, 1994 for collection data). The exception was Uracas. It is likely that this species was not present on

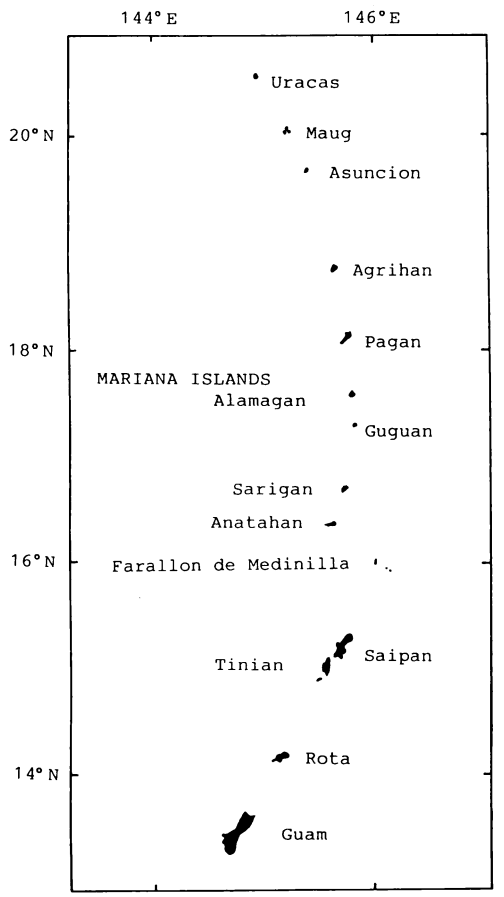


**Fig. 1.** Map of the Mariana Islands. Islands from Uracas to Anatahan constitute the northern Mariana Islands, and those from Farallon de Medinilla to Guam the southern Mariana Islands.

Uracas, because the island is an active volcano and has poor vegetation as well as poor insect fauna. Eighteen colonies were collected in total (Table 1A). The nests were built on various plant species and man-made structures (Fig. 3). The most unique location was inside the cockpit of a wrecked Zero fighter plane. The nesting height differed from ca. 20 to 180 cm above the ground. The colonies showed all colony developmental stages, *i.e.*, from the incipient through the mature to the declining stage. Colony size varied from 6 to 1332 in terms of cell number (Fig. 4A) and from one to 97 in terms of adult number (Fig. 4B). Nine nests (colonies P, Q, D, J, K, N, M, L, and B) were attended by only females, 7 (colonies A, C, E, F, H, G, and I) by both females and males, and one

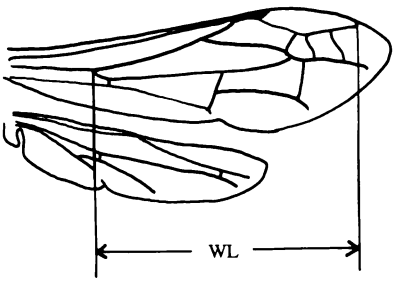


**Fig. 2.** Right wing of female wasp. WL indicates the length of wing measured.

(colony Y) by males only (adults of colony Z were not collected). Males were seen abundantly over the vegetation. For example, all ten wasps caught successively on the canopy of a fig tree, *Ficus tinctoria*, on Sarigan on 15 May were males. Judging from the great variation in colony size and adult composition, it is clear that this species has an asynchronous life cycle in the northern Marianas.

Except for colonies which had no females, each colony had one female with a developed ovary, which was inseminated (Table 2). She was probably the egg layer of the colony. The others had thread-like ovaries, except for three females in two large colonies; one female in colony L which was not inseminated had a moderately developed ovary, and two females in colony I which were inseminated had moderately developed ovaries. These three also had laid eggs in each colony, although the contribution was less than that of females with well developed ovaries. The insemination rate of females (no. of females inseminated/no. of total females, except for those undetermined) was high. In total, more than half the females were inseminated (Table 2).

Females with well or moderately developed ovaries were not always the largest individuals in the colony, but they were significantly larger than the other females. There was no significant difference in body size between inseminated and uninseminated females which had thread-like ovaries (Table 3). These facts suggest that males copulate with females irrespective of the partner's body size, but a large body size is advantageous during competition for becoming a colony egg-layer.

Two small incipient colonies (colonies P and

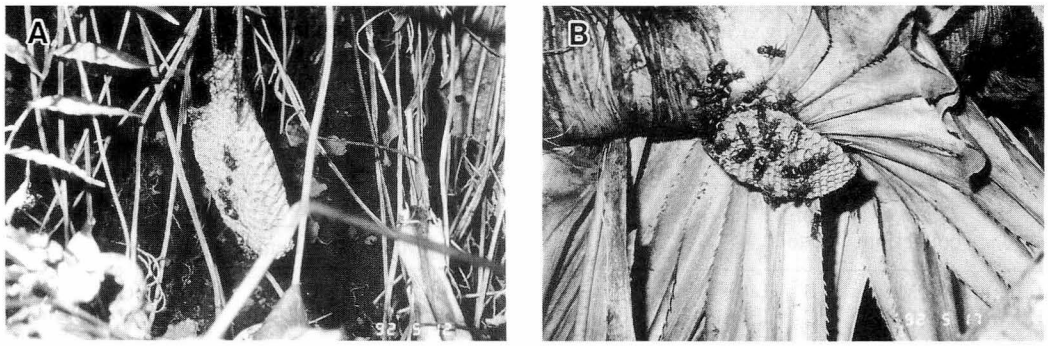


**Fig. 3.** Nests of *R. marginata sundaica*, which were made on the dead stem of a fern on Anatahan (A) and on a stem of *Pandanus tectorius* on Guguan (B). Dead leaves were partially removed.

Q, Table 1A) were each certainly founded by a solitary female, because I recognized only one female on each nest during a three-hour observation period before and after collection.

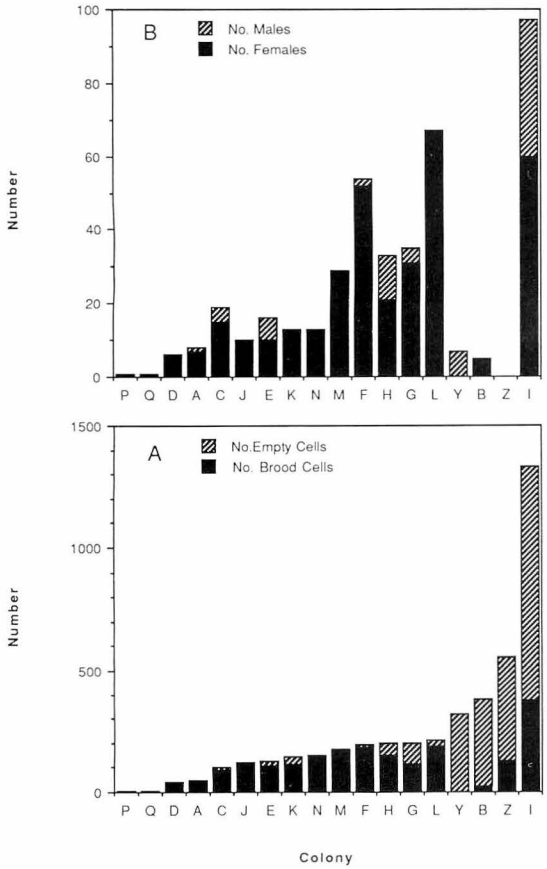


**Fig. 4.** Colony size of *R. marginata sundaica*. The numbers of cells (A) and adults (B) are shown.

### 2. *Polistes olivaceus*

Seven colonies were collected on Pagan and Agrihan (Table 1B). On the other seven islands, no nests nor even flying wasps were found. However, it was difficult to determine whether this species was absent on these islands, because the survey was restricted to a very small area and was conducted in a short time.

Nests were built on the stems of trees and ferns, and on the midribs of coconut leaves at heights ranging from a few tens to 330 cm (Fig. 5). This species was considered to have a synchronous life cycle on these islands. Nest size variation was small in comparison with that of *R. marginata sundaica* (Table 1B). Five (colonies S, T, U, V, and W) out of seven colonies had one large female (Table 4). Of these, four (T, U, V, and W) had a few other small females. Two colonies (colonies, R and AC) had one small female and no adult, respectively. All the large females were inseminated and had swollen ovaries. Four out of five had slightly worn wings. They were probably founding queens. All the small females were uninseminated and their ovaries were thread-like. One was apparently teneral. The number of cells which had cocoon traces was always equal to or larger than that of small females in each colony. No males were collected with the nests or separately. These facts suggested that each colony was founded by a single queen, that small females were first daughters of the founding queen, and that the colony was at a late pre-emergence or early post-emergence stage at the time of collection.

The difference in body size between queens

**Table 1.** Colony record of social wasps collected in the northern Mariana Islands. The number of small incipient cells is designated by +n in the column for No. cells. If two immatures existed in the same cell, the number of younger ones is designated by +n in corresponding stage of the column of No. immatures. Rota is an island in the southern Marianas, but one colony of *P. stigma* collected on it is included in this table.

A. *Ropalidia marginata sundaica*

| Island | Date of collection | Colony code | Substratum | No. adults (on nest) | | No. adults (returning) | | No. cells |
|---|---|---|---|---|---|---|---|---|
| | | | | Female | Male | Female | Male | |
| Anatahan | 12-May | B | Live fern | 4 | 0 | 1 | 0 | 379+15 |
| Anatahan | 12-May | C | Live fern | 11 | 4 | 4 | 0 | 104+ 8 |
| Anatahan | 12-May | D | Live fern | 4 | 0 | 2 | 0 | 41+ 5 |
| Anatahan | 12-May | E | Live fern | 8 | 3 | 2 | 3 | 124 |
| Guguan | 17-May | Y | *Pandanus tectorius* | 0 | 7 | 0 | 0 | 319+ 5 |
| Guguan | 17-May | F | *Pandanus tectorius* | 52 | 2 | 0 | 0 | 194+ 5 |
| Guguan | 17-May | G | *Pandanus tectorius* | 31 | 4 | 0 | 0 | 200+ 1 |
| Alamagan | 18-May | Z | *Pithecellobium dulce* | | | | | 556 |
| Alamagan | 19-May | P | *Pithecellobium dulce* | 1 | 0 | 0 | 0 | 6 |
| Alamagan | 19-May | H | *Pithecellobium dulce* | 16 | 12 | 5 | 0 | 195+ 9 |
| Alamagan | 9-Jun | Q | *Pithecellobium dulce* | 1 | 0 | 0 | 0 | 8 |
| Alamagan | 9-Jun | A | *Pithecellobium dulce* | 3 | 1 | 4 | 0 | 48+ 1 |
| Pagan | 24-May | I | Wrecked Zero fighter | 60 | 37 | | | 1332+ 5 |
| Pagan | 27-May | J | Wall | 7 | 0 | 3 | 0 | 123 |
| Agrihan | 28-May | K | *Piper guahmense* | 9 | 0 | 4 | 0 | 145+ 2 |
| Asuncion | 1-Jun | L | Dead fern | 58 | 0 | 9 | 0 | 212+ 9 |
| Asuncion | 1-Jun | M | Live fern | 19 | 0 | 10 | 0 | 175+ 1 |
| Asuncion | 1-Jun | N | Dead fern | 13 | 0 | | | 151 |
| Total | | 18 | | | | | | |

B. *Polistes olivaceus*

| Island | Date of collection | Colony code | Substratum | No. adults (on nest) | | No. adults (returning) | | No. cells |
|---|---|---|---|---|---|---|---|---|
| | | | | Female | Male | Female | Male | |
| Pagan | 27-May | R | *Hibiscus tiliaceus* | 1 | 0 | 0 | 0 | 27 |
| Pagan | 27-May | S | *Hibiscus tiliaceus* | 1 | 0 | 0 | 0 | 18 |
| Pagan | 27-May | AC | *Hibiscus tiliaceus* | 0 | 0 | 0 | 0 | 16 |
| Agrihan | 29-May | T | Fern | 5 | 0 | 0 | 0 | 40 |
| Agrihan | 31-May | U | Dead coconut leaf | 4 | 0 | 1 | 0 | 47 |
| Agrihan | 31-May | V | Fern | 2 | 0 | 1 | 0 | 48 |
| Agrihan | 31-May | W | Dead coconut leaf | 5 | 0 | 1 | 0 | 52 |
| Total | | 7 | | | | | | |

C. *Polistes stigma*

| Island | Date of collection | Colony code | Substratum | No. adults (on nest) | | No. adults (returning) | | No. cells |
|---|---|---|---|---|---|---|---|---|
| | | | | Female | Male | Female | Male | |
| Anatahan | 12-May | O | *Barringtonia asiatica* | 7 | 3 | 3 | 8 | 129 |
| Rota | 13-Jun | AB | Wall | 1 | 0 | 0 | 0 | 11 |
| Total | | 2 | | | | | | |

and daughters was marked (Table 5). Moreover, their body proportions also differed. The thorax was wider than the head in queens, but narrower than the head in daughters. However, this does not imply a morphological caste differentiation in this species, because this difference can be explained by allometric growth. Irrespective of whether an individual is a

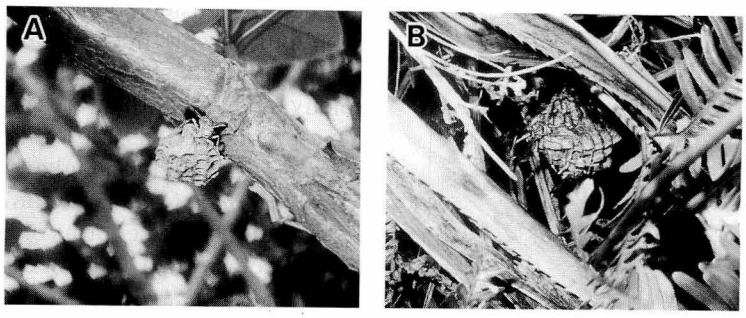


**Fig. 5.** Nests of *P. olivaceus*, which were made on the stem of a tree, *Hibiscus tiliaceus*, on Pagan (A) and under the dead leaf of a coconut tree on Agrihan (B).

two had an asynchronous, and one a synchronous life cycle. This means that two types of life cycle coexist in the same tropical region. It would be interesting to clarify which factors other than meteorological ones determine the life history of these social wasps.

Solitary colony founding was confirmed in all three social wasp species. Although it is not clear whether other types of colony founding (swarm-founding and pleometrotic colony founding) exist, it is noteworthy that solitary colony founding occurs in the tropics, because solitary colony founding is usually considered

**Table 4.** Female composition of each colony of *Polistes olivaceus*. Large female had swollen ovaries and was inseminated. Small ones had thread-like ovaries and were uninseminated.

| Colony code | No. large females | No. small females |
|---|---|---|
| R | 0 | 1 |
| S | 1 | 0 |
| AC | 0 | 0 |
| T | 1 | 4 |
| U | 1 | 4 |
| V | 1 | 2 |
| W | 1 | 5 |

**Table 5.** Comparison of body size of *P. olivaceus* females. WL=wing length, HW=head width, and TW=thoracic width. Mean±S.D. are shown in mm. *p* is a probability of significance (Mann–Whitney U-test).

| | *n* | WL | HW | TW |
|---|---|---|---|---|
| Large females | 5 | 12.33±0.48 | 4.74±0.14 | 5.06±0.19 |
| Small females | 16 | 9.90±0.42 | 4.10±0.11 | 4.00±0.15 |
| *p* | | 0.0009 | 0.0008 | 0.0008 |

**Table 6.** Results of dissection, body size, and other data for *P. stigma* females from colony O. N=caught on nest, R=returning. Ovary: 1=thread-like, 2=a little thick, 3=somewhat swollen without mature egg, 4=well developed with mature eggs. Wing wear: 0=no wear, 1=slight wear, 2=moderate wear, 3=heavy wear, 4=extremely heavy wear. WL=wing length, HW=head width, and TW=thoracic width in mm.

| Individual No. | N or R | Ovary | Insemination | Wing ware | WL | HW | TW |
|---|---|---|---|---|---|---|---|
| 6 | N | 4 | No | 0 | 6.95 | 3.10 | 3.10 |
| 5 | N | 4 | No | 2 | 7.05 | 3.05 | 3.10 |
| 1 | N | 4 | No | 0 | 7.20 | 3.15 | 3.20 |
| 2 | N | 4 | No | 0 | 7.45 | 3.15 | 3.20 |
| 3 | N | 4 | No | 0 | 7.80 | 3.20 | 3.30 |
| 9 | R | 3 | No | 0 | 6.60 | 3.00 | 2.90 |
| 10 | R | 2 | No | 0 | 6.75 | 3.05 | 3.05 |
| 8 | R | 2 | No | 0 | 7.15 | 3.10 | 3.10 |
| 7 | N | 2 | No | 0 | 7.60 | 3.20 | 3.40 |
| 4 | N | 1 | No | 0 | 7.70 | 3.25 | 3.40 |

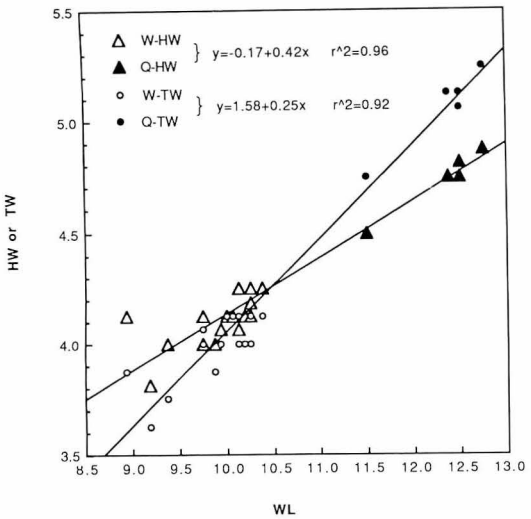


**Fig. 6.** Relationship between wing length (WL) and head width (HW) or thoracic width (TW) in *P. olivaceus* females. *W-* means value of workers, and *Q-* value of queens.

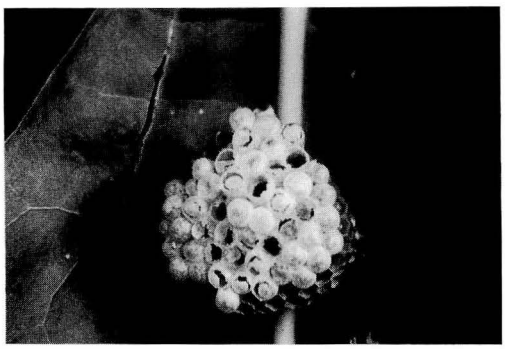

**Fig. 7.** Nest of *P. stigma*, which was made under the leaf of a tree, *Barringtonia asiatica*, on Anatahan.

to be inferior against predation at these latitudes (Suzuki and Ramesh, 1992).

In *P. olivaceus*, first daughters were markedly smaller than the queen. This phenomenon is also known for some social wasps (*Polistes chinensis antennalis*, Miyano, 1983; *P. jadwigae*, Miyano, per. ob., *R. fasciata*, Kojima, 1989; *Parapolybia indica*, Sugiura *et al.*, 1983; *Mischocyttarus drewseni*, Jeanne, 1972), and suggests the manipulation of the larval growth of first daughters by the queen (Miyano, 1990).

In *R. marginata sundaica*, more than half the females were inseminated by males, which were abundant in the population. Therefore, females are considered to have wider behavioral options, to work in the natal colony, to found a new colony, to stay and lay eggs in the natal colony, and so on, than those of species which have a synchronous life cycle. Females of *R. marginata* in India (Gadagkar *et al.*, 1990) and *R. cyathiformis* (Gadagkar, 1987) are known to exhibit these diverse forms of behavior. Usually one colony had only one egg layer in *R. marginata sundaica*, unless the number of females in it exceed about 60. A similar example is known for *R. marginata* in India, in which multiple egg-layers appear and female exodus occurs if the number of females exceeds 40 (Gadagkar *et al.*, 1982).

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