

Habitat and foraging observations on an oriental bumble bee (Hymenoptera Apidae)

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Bombus baguionensis is found above about 1400 m on Mt Banahaw, Luzon, Philippines. Only two other social bees and very few solitary bees were observed at these elevations.

Around the end of the dry season, bumble bees were found foraging at seven species of flowering plants, of which three accounted for all but a very few visits. Behavioral observations and analysis of pollen loads show *Melastoma polyanthum* (Melastomataceae) as the almost exclusive pollen source. *Hedyotis elmeri* (Rubiaceae) appears to be the main nectar source, with *Rubus rosaefolius* (Rosaceae) inferred as a secondary nectar source.

Bees also drank human urine on fallen leaves, presumably as a source of salts.

The period of foraging activity on a northwest-facing slope was closely congruent with the period of daylight, about 05:30-18:00. Data from a nectar-plant patch and a predominantly pollen-plant patch are consistent with a gradual switch from pollen-foraging to nectar-foraging throughout the day.

KEY WORDS: *Bombus*, bumble bee, pollination, Southeast Asia, Philippines.

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INTRODUCTION

The bumble bees (*Bombus* spp.) are perhaps the most characteristically temperate large taxon of social insects, with only a modest tropical presence (MICHENER 1974, HEINRICH 1979). There have been several studies of neotropical bumble bees (DIAS

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1958, SAKAGAMI et al. 1967, JANZEN 1971, GARÓFALO 1978, HEITHAUS 1983, LAVERTY & PLOWRIGHT 1985) and one oriental species (MICHENER & AMIR 1977). We present here some ecological observations on a second oriental species, *B. baguionensis* Cockerell 1920, one of three species recorded from the Philippines (BALTAZAR 1966).

HABITAT

All field observations are by the senior author during April 1985 and April-May 1986 on Mt Banahaw (14°N 121°E, altitude 2158 m; BOARD OF TECHNICAL SURVEYS AND MAPS 1961) in Quezon province, Luzon, Philippines. Bumble bees were found from about 1400 m up to the Durungawan peak area at about 2100 m. They seemed abundant above about 1600 m. Their habitat varied from dipterocarp forest to mossy forest and appeared little disturbed.

These observations are consistent with the conclusion (MICHENER 1974) that bumble bees in tropical Asia are mainly restricted to the highlands. Within the Philippines this is further corroborated by published (BALTAZAR 1966) and unpublished (pers. obs.) collecting records. In particular, Mt Makiling (1109 m), which is about 30 km from Mt Banahaw and relatively undisturbed in its upper part, has been well enough collected that we can be sure that it has no bumble bees.

Scents in the air and droppings on the ground gave good evidence of the presence of the civet *Viverra zangalunga* Gray 1832 or/and palm civet *Paradoxurus hermaphroditus* (Pallas 1777) in the study area. Arthropods make up much of the diet of these omnivorous mammals (DAVIS 1962, ALCALA & BROWN 1969), so that either is a likely candidate as a predator at bumble bee nests.

The bee fauna seemed generally depauperate at altitudes where bumble bees were abundant. The only other social bees found were the honey bees *Apis breviligula* Maa 1953 and *A. cerana* Fabricius 1793. Conspicuously absent were stingless bees (*Trigona* spp.), which one of us (C.K. Starr) found abundant in nearby lowland forest and farmland. Carpenter bees (*Xylocopa* spp.) were occasionally seen in the crowns of flowering trees, but seemed on the whole much less abundant than in the lowlands. These observations suggest (i) no strong foraging competition between bumble bees and honey bees, in contrast to what seems to prevail in much of North America (HEINRICH 1979), and (ii) that *B. baguionensis* has little competition from solitary bees.

FOOD PLANTS

Three flowering plants seemed especially attractive to bumble bees. In approximate descending sequence they were *Hedyotis elmeri* Merrill 1906 (Rubiaceae), *Melastoma polyanthum* Blume 1831 (Melastomataceae) and *Rubus rosaefolius* Smith 1790 (Rosaceae) (Fig. 1). Of the other common plants, only four species were seen visited. Honey bees also visited each of the three preferred plants, but were seen often only at *R. rosaefolius*. *A. breviligula* was seen in greatest numbers at flowers of an unidentified tree which was never seen visited by bumble bees. Few trees in the study



Fig. 1. — Flowers of plants most visited by *Bombus baguionensis*: a, *Hedyotis elmeri*; b, *Melastoma polyanthum*; c, *Rubus rosaeifolius*.

area were so high that at least the larger bees (*B. baguionensis*, *A. breviligula*, *Xylocopa* spp.) in the crown could not be seen and confidently identified.

Flowers of *H. elmeri* (Fig. 1a) are small, with a moderately deep corolla which opens mostly laterally. Bees extended the proboscis into each flower visited, evidently collecting nectar. They did not show the leg movements which move and concentrate pollen dusted onto the body (GARY 1975: fig. 14, JANDER 1976). *M. polyanthum* flowers (Fig. 1b) are large, shallow and tend to open upwards. Bees buzz-collected pollen (THORP 1979, BUCHMANN 1983, CORBET et al. 1988) at this plant and showed pollen-packing movements. Like most presumed buzz-pollinated plants, *Melastoma* is nectarless (BUCHMANN 1983). *R. rosaefolius* has medium-sized, relatively shallow flowers (Fig. 1c).

Reference pollen samples are deposited at the National Museum of the Philippines. Voucher specimens of all named plant species are in the herbaria of De La Salle University and the National Museum of the Philippines, and a voucher of *H. elmeri* is at Harvard University. Vouchers of *B. baguionensis* are in the British Museum (Natural History), Smithsonian Institution, University of Kansas, University of the Philippines (Los Baños) and University of Toronto.

Foraging-period observations are from two patches of plants. Patch A (about 1650 m) was in a northwest-sloping clearing dominated by several *H. elmeri* shrubs. Patch B (about 2000 m), in a west-sloping clearing, comprised a single very large *M. polyanthum* shrub, several *R. rosaefolius* shrubs and several other plants little visited by bumble bees.

Pollen loads from two bees collected foraging at *H. elmeri* and 14 at *M. polyanthum* showed at least nine species of pollen grains. None except *M. polyanthum* appeared in large measure in any load. One load from the first group and seven from the second group were pure, and in the mixed loads *M. polyanthum* pollen accounted for roughly 90% of the total.

The two plants most visited by *B. baguionensis* — *H. elmeri* and *M. polyanthum* — evidently function quite differently in its food economy. The first contributes nectar and very little pollen, while the second contributes no nectar and most of the pollen. The (mostly negative) evidence suggests *R. rosaefolius* as the second-line nectar source.

On several occasions bumble bees were seen drinking urine from the leaf litter. In doing this, they presumably gain salts, as do a wide variety of bees from this and other sources (ROUBIK 1989). A recent review of bumble bee foraging (MORSE 1982) makes no mention of urine, but *B. terricola* Kirby 1837 has repeatedly been observed drinking urine in Ontario, Canada (R.C. PLOWRIGHT pers. comm.).

ACTIVITY CYCLE

Observations emphasized three focal periods designated as the early (05:30-08:30), midday (11:00-14:00) and late (16:00-18:00) periods and were suspended for at least an hour after rain. To study nectar-foraging periodicity in Patch A, the number of worker bees present was recorded during at least 10 min of each half-hour daylight period on at least 2 days, for a total observation time of 35-80 min/period. Pollen loads from bees and reference samples from flowers were examined by the junior author.

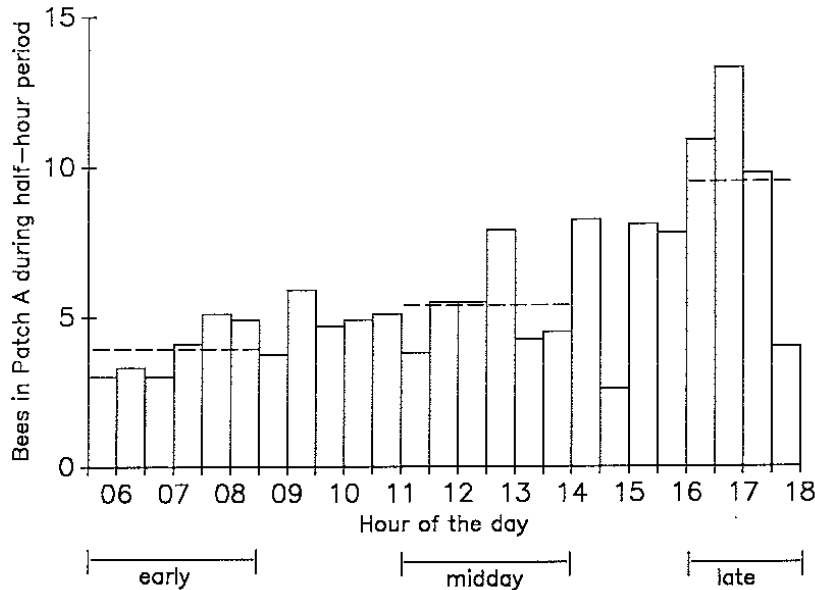


Fig. 2. — Mean number of worker bumble bees visiting Patch A during each half-hour daylight period. The three focal periods for behavioral observation are indicated at bottom. Dashed horizontal lines indicate means for each focal period.

While all foraging seemed to stop during rain, *H. elmeri* and *M. polyanthum* appeared to be treated differently when the rain stopped. Visits to *H. elmeri* resumed fairly quickly, while foraging at *M. polyanthum* seemed suspended for the rest of the day.

Sunrise on Patch A was at about 07:15 and sunset at about 18:30, with the period of daylight being about 05:30-18:00. Virtually no bumble bees were seen or heard flying outside of daylight. Fig. 2 shows the number of workers in Patch A at different times of day. The raw data show a significant departure from randomness among half-hour periods (χ^2 test, $P < 0.01$), as well as among the three focal periods. However, there is no significant difference between the early and midday focal periods ($P > 0.05$).

Table 1 shows the distribution of bees without and with pollen loads among those seen visiting Patch A during 1 day. Where the pollen baskets showed only a

Table 1.

Numbers of bees without and with pollen loads foraging in Patch A during the three focal periods of 1 day. Explanation in text.

Period	Without pollen	With pollen	Total
Early	1	15	16
Midday	10	28	38
Late	23	8	31
Total	34	51	85

Table 2.

Numbers of bees without and with pollen loads foraging in Patch B during the early and midday periods of 1 day. Explanation in text.

Period	Without pollen	With pollen	Total
Early	1	30	31
Midday	9	24	33
Total	10	54	64

trace of pollen, this is assumed to be a remnant from an earlier trip and the bee was counted as having no load. The observed difference among focal periods is significant (χ^2 test, $P < 0.01$), though the difference between the early and midday periods is not ($P > 0.05$).

Table 2 gives corresponding data for bees visiting (mostly *M. polyanthum*) flowers in Patch B during the early and midday periods of 1 day. The observed difference is significant ($P < 0.01$). It rained after the midday period, and no bees arrived during the late period.

During both the early and midday periods, the two patches were very similar in the fraction of bees with pollen loads (Tables 1 and 2) ($P > 0.05$).

ALLEN et al. (1978) recorded the times of almost 2000 departures and arrivals at a nest of *B. vosnesenskii* Radoszkowski 1862 during 1 day. Although our approach to this question differed, the results (Fig. 2) are similar to their finding of foraging throughout the period of daylight, with a gradual increase throughout the morning followed by sustained activity until about dusk. However, some other temperate *Bombus* spp. show quite different patterns from this (reviewed by PLOWRIGHT & LAVERTY 1984). *B. baguionensis* visited nectar flowers throughout the daylight hours. It showed an increase in activity in late afternoon, with no very strong peak and no evident intermediate lulls.

While they did not quantify the result, ALLEN et al. (1978) found a fairly constant proportion of returning *B. vosnesenskii* workers with pollen loads throughout the day. If bees observed at Patches A (Table 1) and B (Table 2) were representative of their colonies, *B. baguionensis* behaves quite differently. The close similarity of the two patches during both the early and midday periods leads us to expect that late-period data from Patch B, if it were available, would show very little pollen-collecting and probably few bees visiting the patch. If this is so, the late-afternoon peak of activity observed in Patch A (Fig. 2) may represent a switch to nectar foraging more than an overall increase in flight activity.

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